Marine Engineering

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Fig. 1.—S. S. *Hawkeye State* on Trial Trip, January 17, 1921

Passenger and Cargo Steamship Hawkeye State

The steamship Hawkeye State, the first of the sixteen 535-foot passenger and freight steamers being built for the United States Shipping Board, has been completed by the Bethlehem Shipbuilding Corporation, Ltd., at their Sparrow's Point, Md., Plant, and placed in service by the Matson Navigation Company, San Francisco, Cal., the first sailing being from Baltimore through the Panama Canal to San Francisco and Hawaii. The Sparrow's Point Plant has four more of these vessels at present under construction and nine similar ships are being built by the New York Shipbuilding Corporation, Camden, N. J., and two by the Newport News Shipbuilding and Dry Dock Company, Newport News, Va.

THE hulls of the 535-foot passenger vessels now under construction for the Shipping Board were originally laid out as troop transports, due regard being given to the possibility of ultimately converting them into first-class combined passenger and cargo steamers. In order to avoid as far as possible duplication of work in some cases where several builders had contracts for sister vessels with the United States Shipping Board Emergency Fleet Corporation, the design work was divided up and an interchange of plans effected, which resulted in a great saving to the government. This work was divided between the New York Shipbuilding Corporation and the Bethlehem Shipbuilding Corporation, Ltd., the former company supplying the structural plans and the latter the interior arrangements and architectural features.

A detailed description of the structural features of these vessels has already appeared in MARINE ENGINEERING (see page 260, April, 1920 issue), and need not be referred to beyond stating that the *Hawkeye State* is the largest passenger vessel constructed on the longitudinal system of framing. The principal dimensions and the principal data covering both hull and machinery will be found on page 190.

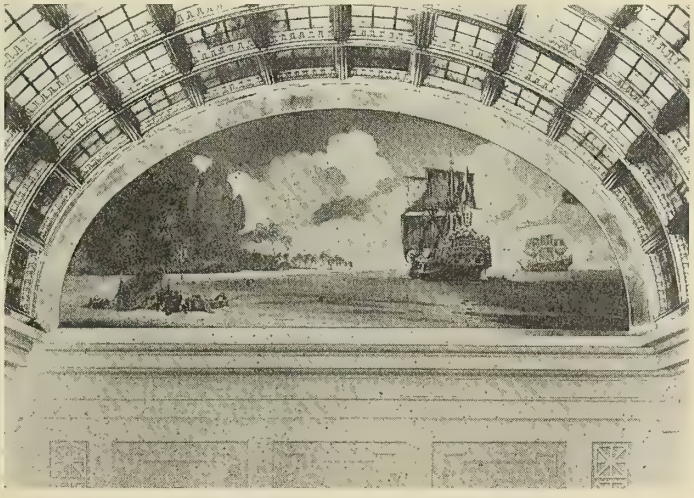


Fig. 2.—Main Stairhall Dome, Looking Forward

GENERAL ARRANGEMENT

The lower deck is complete throughout the cargo holds and the upper, shelter and shade decks are continuous for the length of the ship. There are thirteen complete watertight bulkheads extending to the shelter deck, twelve of which extend also to the shade deck.

The cargo spaces are divided into nine holds, five forward and four aft of the machinery spaces. The double bottoms are fitted for fuel oil except for the re-

serve feed tank under the engine room; 1,221 tons of oil are carried in deep tanks abreast the boiler rooms and extending to the upper deck.

The bridge deck is 228 feet long, and hatches Nos. 5 and 6 are located on this deck. Forward of No. 5 hatch is the forward boat deck house, wheel house and chart room and flying bridge. Between hatches Nos. 5 and 6 are the main bridge deck and boat deck houses. On the shade deck aft is a steel house.

Accommodations for First-Class Passengers

The accommodations for the first-class passengers are the equal of those on any ships of this type afloat, both architecturally and from the standpoint of comfort and convenience.

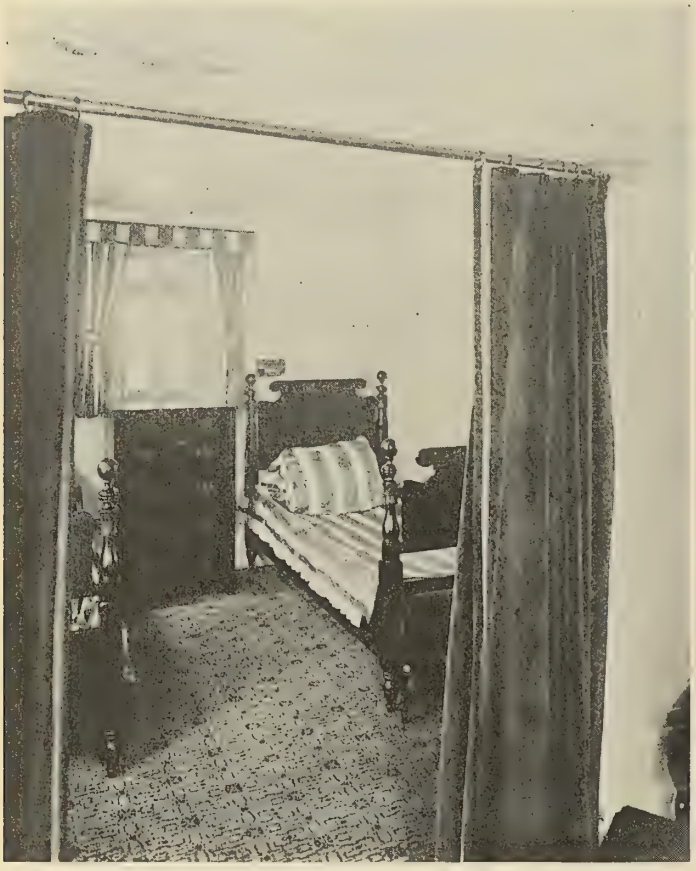


Fig. 3.—Bed Room in Private Suite, Bridge Deck

Fig. 4.—Stairhall from Shelter Deck, Entrance Lobby

The thoroughly American character of the ship is carried out by the elimination of second-class passengers, the only difference in accommodations being in the size and location of staterooms and the private baths, and not in the architecture, or by any divisions of the public spaces.

The nationality of the ship is further emphasized by the style of architecture, which is American Colonial throughout. The first-class quarters are finished in light colorings and hangings, well adapted for the tropical route on which the ship will trade.

The passengers enter the ship through side ports into the lobby forward of the dining saloon on the shelter deck. This lobby and all shelter and upper deck lobbies and passages are finished in cream white enamel, the cream of the woodwork being very slightly lighter in shade than the vehisote panels. The floors of these spaces are covered with bluish gray interlocking rubber tiling.

Forward of the above lobby are fifteen staterooms, only two being inside rooms. These, in common with all first-class staterooms on the ship, have the same cream colored woodwork as the passages, but the paneling is stippled light sky blue with touches of gold leaf on the borders and moldings. The doors, tables, settee berths, bureaus and handrails are mahogany, and the beds are metal, one of them folding out of sight.

The rooms in this part of the ship are not provided with private baths, but each room has a lavatory with running hot and cold water. The floors of all staterooms are covered with Wilton rugs. In this space, on the starboard side next to the entrance lobby, is an up-to-the-minute barber shop.

Main Dining Saloon

Aft of the lobby already described is the main dining saloon, furnished with circular mahogany tables seating six persons each in mahogany armchairs. This room is finished in pale green shades, with dark green curtains, hangings and a liberal amount of gold leaf for finish over head. The floor is interlocking rubber tile in white and red. In the center is a semi-cylindrical gilded dome with small art glass panels lighted from above. At the ends of this dome are two mural paintings depicting ancient and modern fleets. Large mirrored mahogany buffets are aft of the dome.

Double doors lead from the aft port side of the dining saloon to the first-class pantry and aft on the starboard side are five more first-class staterooms. These rooms have private baths and are among the best on the ship. If desired, these rooms could be given over to one party, as they have their private stairway to the shade deck and could be closed off from the quarters aft.

Aft of the engine hatch a large stairway from the shade deck leads to the forty-six after shelter deck staterooms. These rooms will be among the least expensive on the ship. However, each room has an upholstered settee berth in addition to the two regular berths; each room also has a closet and running water.

A double stairway leads from the shelter deck lobby at

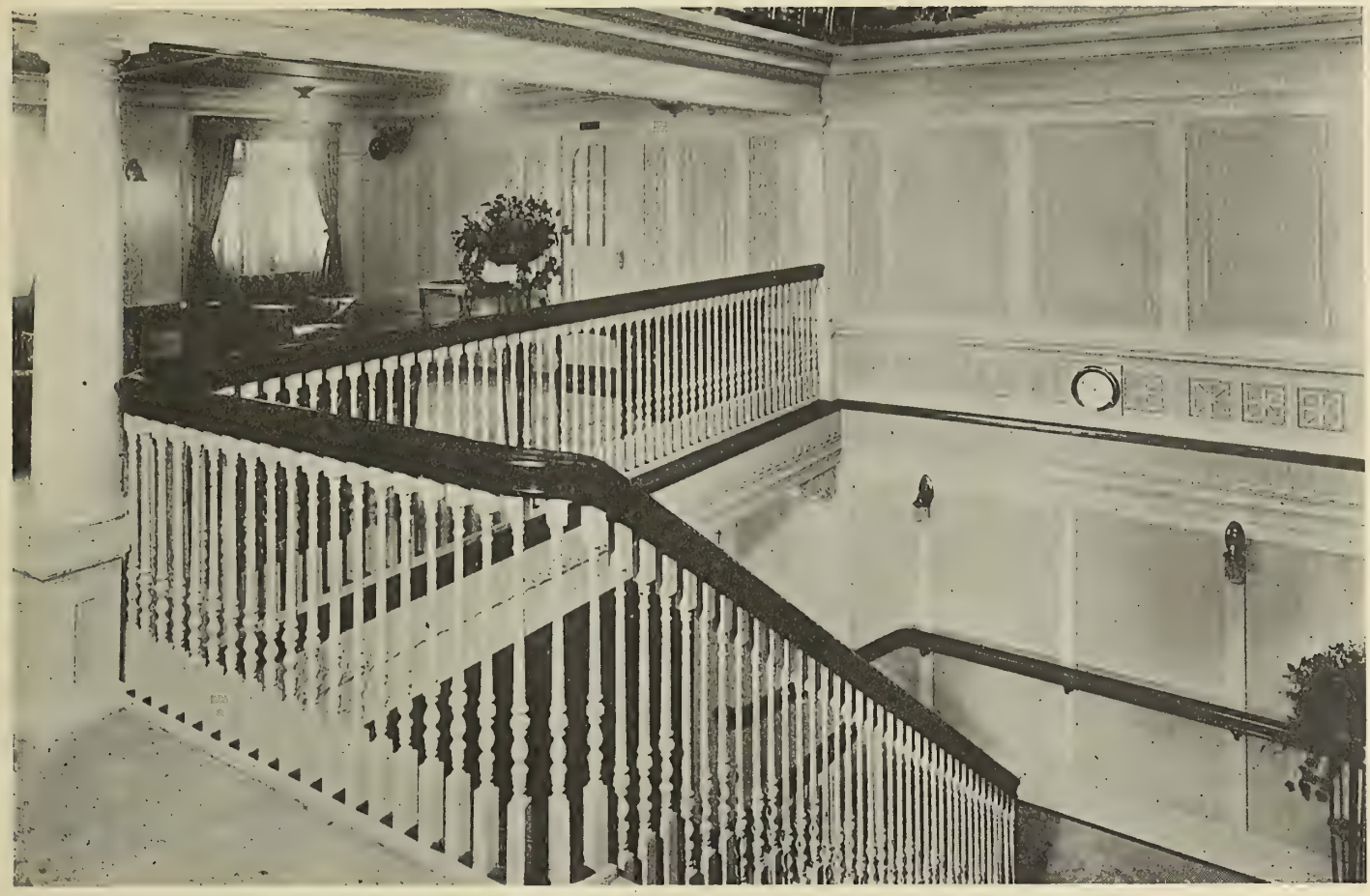


Fig. 5.—Lobby and Main Stairway, Boat Deck, Looking Forward

Fig. 6.—Main Dining Saloon, Shelter Deck, Looking to Port

Fig. 7.—Tea Room, Boat Deck, Starboard Side, Looking Forward

Fig. 8.—Writing Room, Boat Deck, Looking Aft

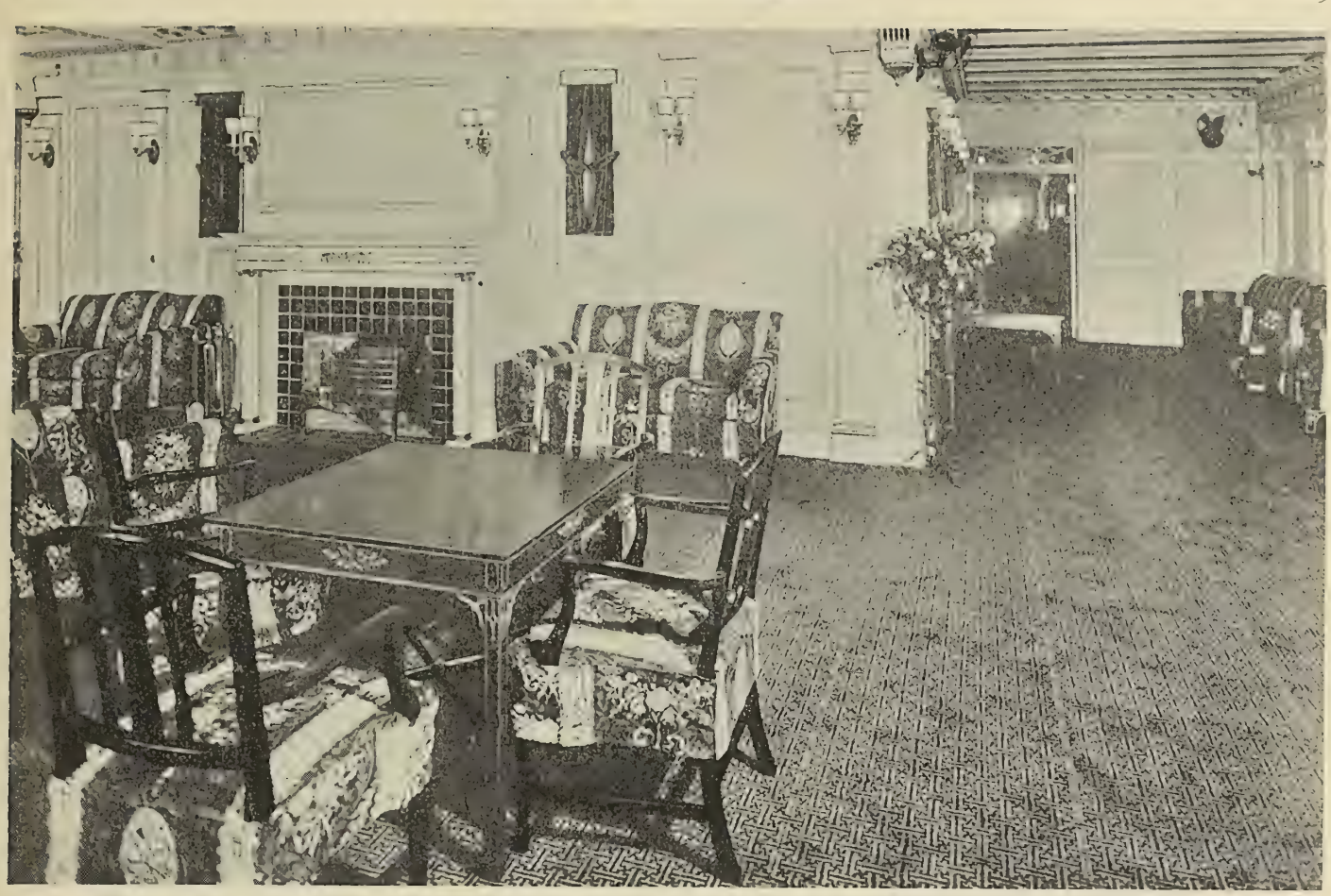


Fig. 9.—Social Hall on Bridge Deck, Port Side, Looking Aft

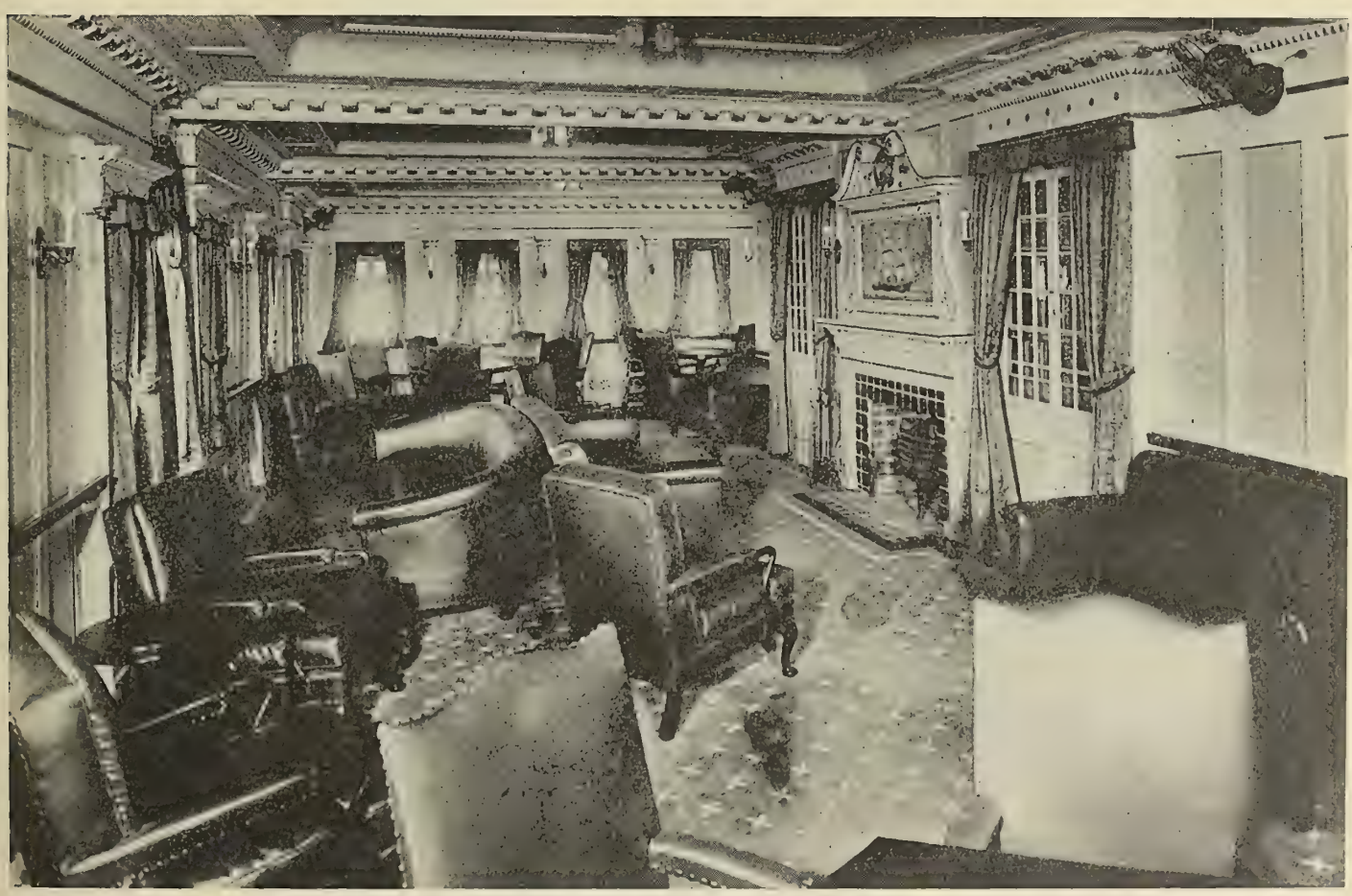


Fig. 10.—Smoking Room, Bridge Deck, Looking to Port

Passenger and Cargo Steamship Hawkeye State

General Information

Service: San Francisco and Hawaii, passenger and freight.

Builder: Sparrow's Point (Md.) Plant, Bethlehem Shipbuilding Corporation, Ltd.

Owner: United States Shipping Board. Allocated to Matson Navigation Company, San Francisco, Cal.

Characteristics

Length, overall.....535 feet
Length on waterline.....534 feet
Beam, molded.....72 feet
Depth to "A" or shade deck, molded..50 feet
Depth to "B" or shelter deck, molded 41 feet
Draft, summer freeboard..30 feet 6¼ inches
Block coefficien at 30 feet 6¼-inch draft 0.633
Midship coefficient 0.99
Longitudinal coefficient 0.642
Speed, on trial, knots.....19
Cruising radius, at 16 knots, nautical miles 13,500
Framing .....Longitudinal
Class ....A-1 American Bureau of Shipping

Tonnages

(In tons of 2,240 pounds)

*Weight of hull 8,340
**Weight of propelling machinery....1,040
Deadweight capacity, at 30 feet 6¼-inch draft, approximately 11,900
Displacement, at 30 feet 6¼-inch draft.. 21,300
Tons per inch immersion.....68.6

(In tons of 100 cubic feet)

Gross register.....14,124
Net register 8,383

*Weight of hull includes hull proper, hull fittings, equipment and outfit.

**Weight of propelling machinery includes engines, boilers (wet), shafting, propellers, and machinery space auxiliaries.

Canal Ratings

(In tons of 100 cubic feet)

	Gross	Net
Suez	14,606	10,077
Panama	15,234	10,434

Complement

Deck department	42
Engine department	45
Stewards' department	108
Miscellaneous	8
Total crew	203
First-class passengers	259
Steerage passengers	302
Total passengers	561.
Miscellaneous	10
Total complement	774

Handling Equipment

	No.	Type	Capacity	Length
Masts	2	Topmasts		
King posts	10			
Booms	32	wood	6 tons	Outboard, 53' Inboard, 46'
	1	steel	30 tons	58'

Discharging capacity.....500 tons per hour

Deck Machinery

Steering gear.....Screw gear type, 16" by 12".
Windlass (1).....Triple spur geared, 13" by 13".
Steam gypsies (2).....10" by 10".
Winch heads for warping ship (2).
Winches (8).....Compound geared
Winches (24) ....Single geared, 9" by 12".

Life Saving Equipment

Lifeboats	No.	Type	Length
Lifeboats	15	Double decked	26'
	2	motorboats	24'
	2	work boats	18'

Propelling Machinery

Boilers

Number 8
Type .....Yarrow watertube
Length .....12 feet 10 inches
Width .....16 feet 6 inches
Fuel .....Oil
Number of Burners per boiler.....5
Draft .....Forced, closed stokehold system
Total heating surface, square feet....40,000
Total furnace volume, cubic feet.....4,896
Ratio of furnace volume to heating surface 0.1224
Superheat, degrees F. 75
Working pressure, pounds per square inch 265
Normal fuel consumption:
Per day, tons 115
Per horsepower hour, pounds....0.9
Normal steam production:
Per hour per pound of fuel....14.25
Total per hour 153,000

Engines

Number 2
Type .....High and low pressure Curtis multi-stage impulse turbines.
Size .....Each unit, 6,000 horsepower
Shaft horsepower, total.....12,000
Shaft horsepower, maximum.....13,200

Propellers

Number 2
Type .....Three-bladed, solid, manganese bronze.
Weight .....23,000 pounds
Diameter ..... 16' 6"
Pitch ..... 17'
R. P. M. 125
Projected area .....72.6 square feet
Developed area .....85 square feet

Auxiliary Machinery

Refrigerating Machinery

2 15-ton York CO_2 machines.
1 ice machine, 1,000 pounds per day.

Machinery Space

2 main condensers, 7,200 square feet cooling surface each.
1 auxiliary condenser, 1,500 square feet cooling surface.
2 evaporators, Griscom-Russell, 35 tons each.
2 distillers, Griscom-Russell, 3,000 gallons per day each.
1 charcoal filter, Griscom-Russell, 3,000 gallons per day, each.
1 aerator
1 feed water heater, Row & Davis.
1 feed and filter tank.....1,000 gals.
1 supplementary feed and filter tank .....240 gals.

Pumps (supplied by Dean Bros.):
2 main feed, v. s., 18" x 12" x 24"
1 aux. feed, v. s., 10" x 7" x 24"
1 ballast, h. d., 10" x 12" x 12"
1 fire, bilge and general service, h. d., 12" x 8½" x 12"
1 sanitary, v. d., 8" x 8" x 12"
1 engine room and 1 fire room bilge, v. s., 5½" x 7" x 12"
1 fresh water, 1 evaporator feed, 1 hot water return, h. d., 7" x 6" x 10"
1 drinking water, h. d., 4" x 3¾" x 5"
1 aux. air, v. s., 10" x 18" x 12"
1 oil transfer, v. s., 8" x 8" x 12"
4 lubricating oil and 2 cooler, v. s., 8" x 10" x 14"
1 ice machine condenser circulating and 2 brine circulating, h. d., 6" x 6" x 6"
1 centrifugal aux. circulating, 10" suction and discharge driven by 7" x 6" reciprocating engine
2 main turbine-driven, centrifugal, Worthington double suction circulating.
4 Radojet air pumps
4 10 H. P. turbo-driven condensate pumps

Electric Equipment

Generators....Four 50-K. W. General Electric, driven by Terry turbines
One 5-K. W. emergency set, driven by gasoline engine

Capacities

Cargo Space

Compartment	Cubic Feet
Hold No. 1	10,505
Lower 'tween decks No. 1	6,699
Upper 'tween decks No. 1	8,135
Shelter 'tween decks No. 1	13,303
Hold No. 2	21,553
Lower 'tween decks No. 2	11,869
Upper 'tween decks No. 2	12,707
Trunked hatch No. 2	5,170
Hold No. 3	31,160
Lower 'tween decks No. 3	16,670
Upper 'tween decks No. 3	16,929
Trunked hatch No. 3	6,460
Hold No. 4	38,345
Lower 'tween decks No. 4	20,585
Trunked hatch No. 4	11,300
Hold No. 5	44,120
Trunked hatch No. 5	23,275
Hold No. 6	35,889
Lower 'tween decks No. 6	22,593
Trunked hatch No. 6	11,300
Hold No. 7	20,546
Lower 'tween decks No. 7	21,801
Upper 'tween decks No. 7	21,251
Trunked hatch No. 7	6,175
Hold No. 8	11,163
Lower 'tween decks No. 8	18,752
Upper 'tween decks No. 8	19,518
Trunked hatch No. 8	6,175
Hold No. 9	6,380
Lower 'tween decks No. 9.....	13,073
Total	513,401

Refrigerated Space

Compartment	Cubic Feet
Meat cargo, port	4,032
ship's consumption	6,021
Butter and eggs	665
Fish	1,140
Poultry	980
Vegetables	1,405
Total	14,243

Bunkers

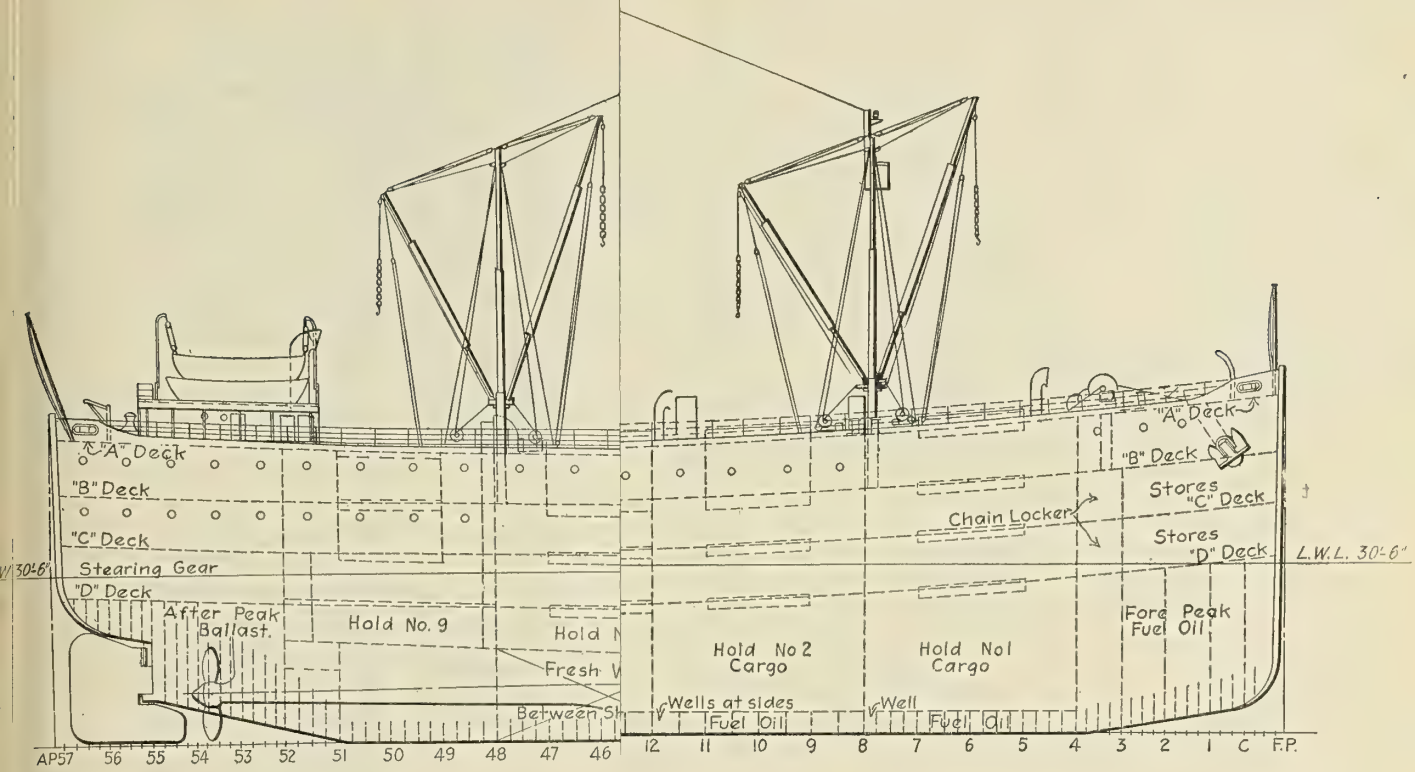
Compartment	Cu. Ft.	Tons
Fore peak tank	5,555	138.9
No. 1 Dbl. bottom P. & S.	1,244	31.1
No. 2 " " "	3,288	82.2
No. 3 " " "	5,791	144.8
No. 4 " " "	7,649	191.2
No. 5 " " "	8,801	220.0
No. 6 " " "	10,038	250.9
No. 8 " " "	9,956	248.9
No. 9 " " "	5,789	144.7
No. 10 " " "	2,534	63.5
No. 24-28 deep tank.....	25,090	627.2
No. 28-32 " "	25,264	631.6
	110,999	2775.0

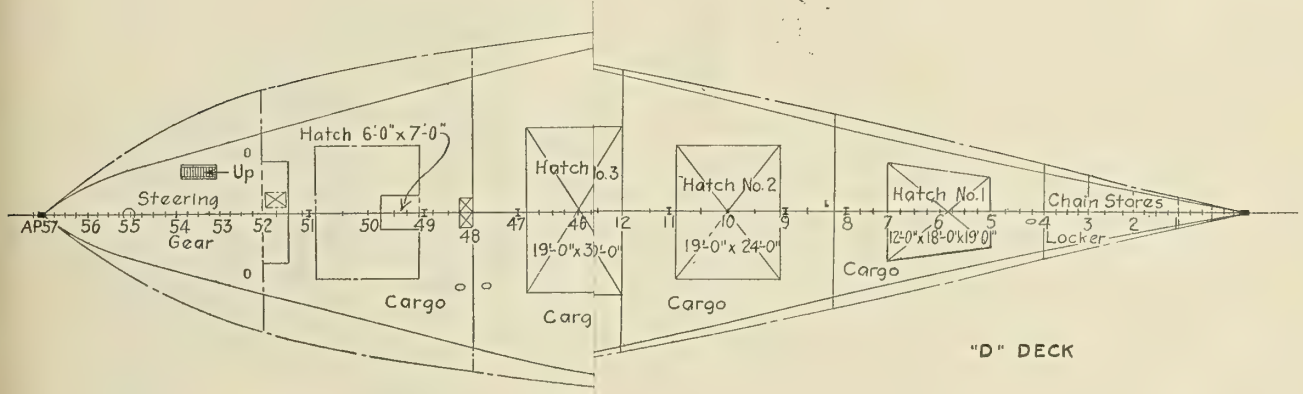
*40 cubic feet per ton; 42 gallons per barrel.

Tanks

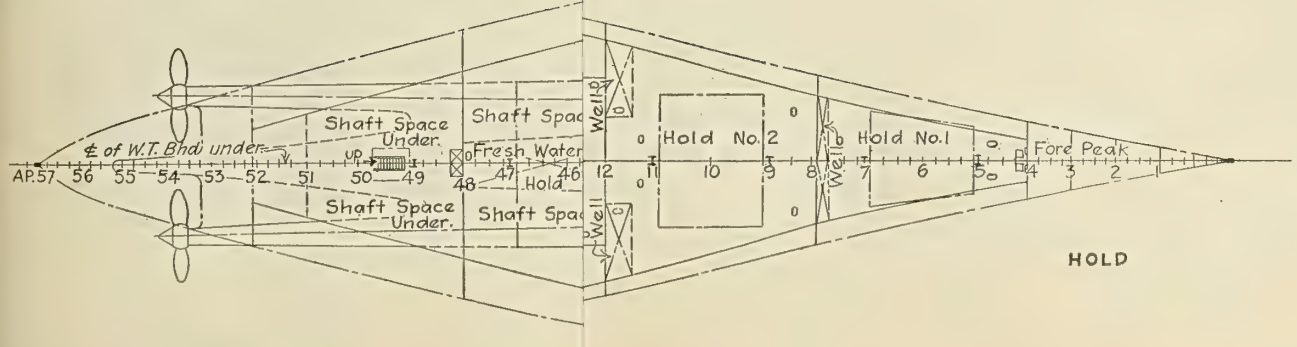
Compartment	Cu. Ft.	Tons F. W.	Tons S. W.
Fore peak tank	5,555		158.7
No. 1 Dbl. bottom P. & S. ..	1,244		35.5
No. 2 " " " ..	3,288		93.9
No. 3 " " " ..	5,791		165.5
No. 4 " " " ..	7,649		218.5
No. 5 " " " ..	8,801		251.4
No. 6 " " " ..	10,038		286.8
No. 8 " " " ..	9,956		284.5
No. 9 " " " ..	5,789		165.4
No. 10 " " " ..	2,534		72.4
After peak tank	5,642		161.2
No. 40 to 44 F. W. tank.....		234.1	
No. 44 to 48 " "		143.9	
No. 33 to 36 Deep "		273.2	
Gravity tanks		6.3	6.7
Total		657.5	1,900.5

PATATE





"D" DECK



HOLD

PASSENGER AND CARGO STEAMSHIP HAWKEYE STATE

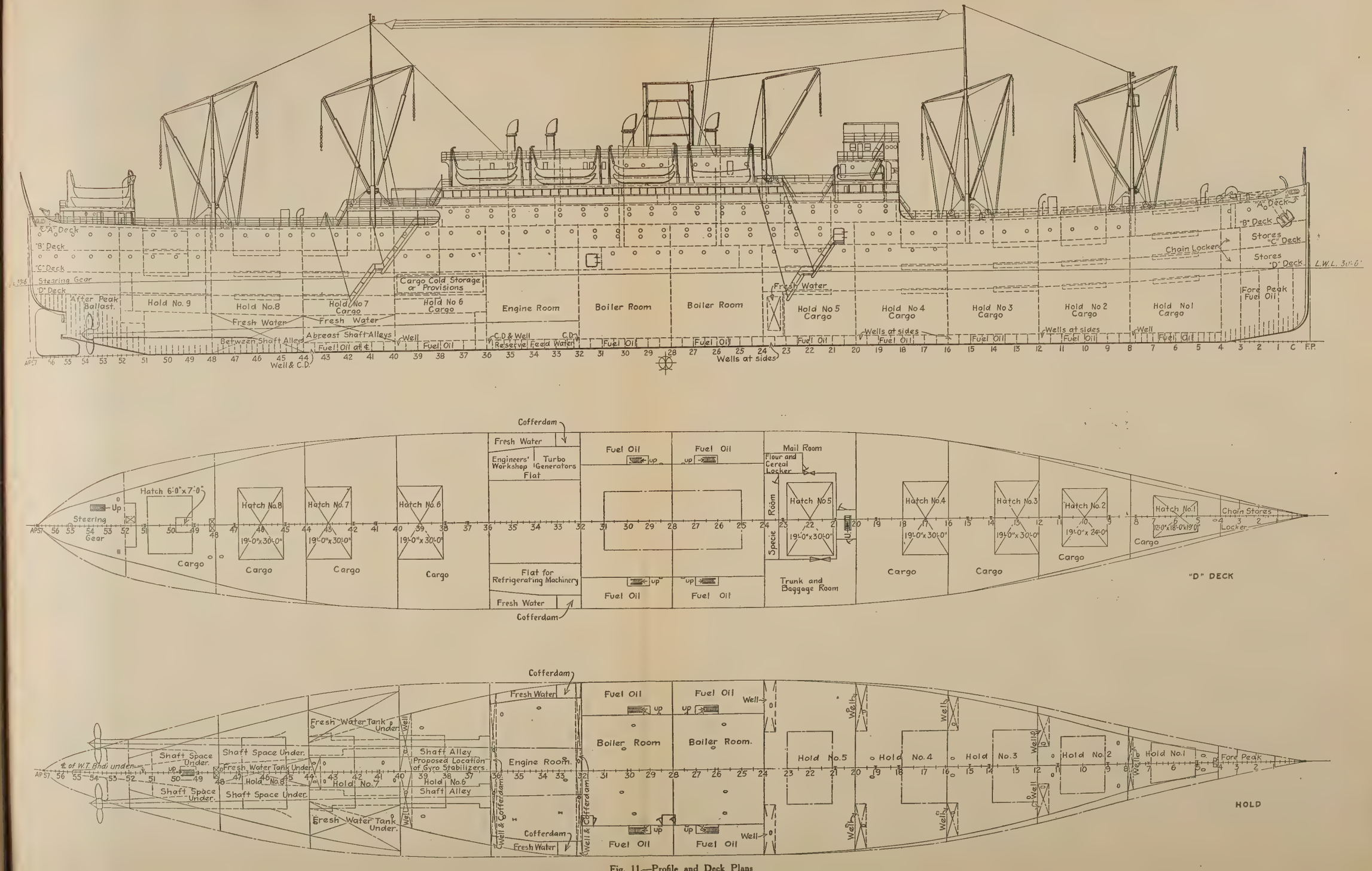
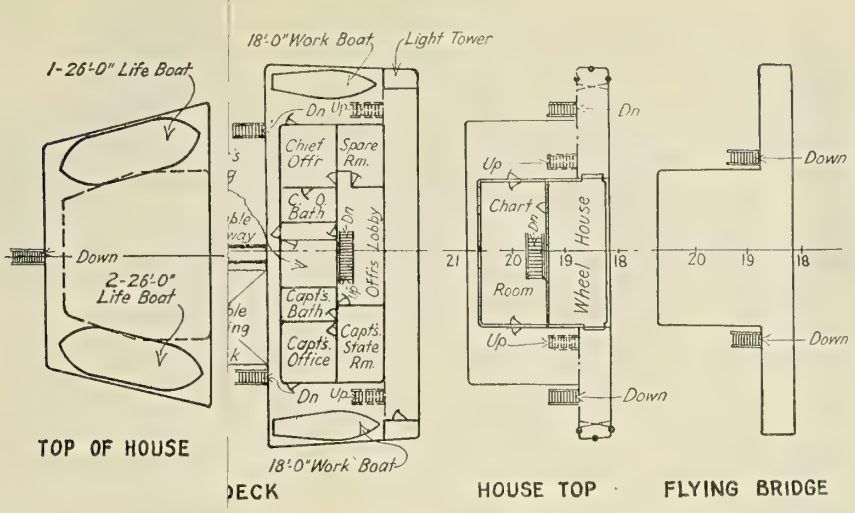
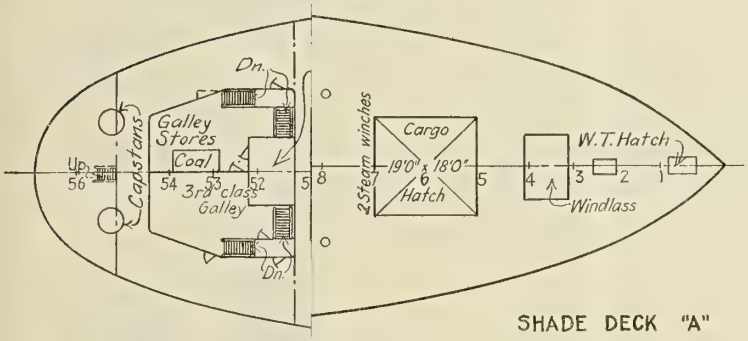
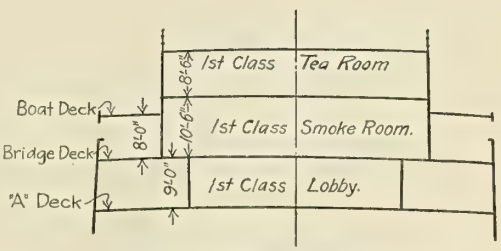


Fig. 11.—Profile and Deck Plans

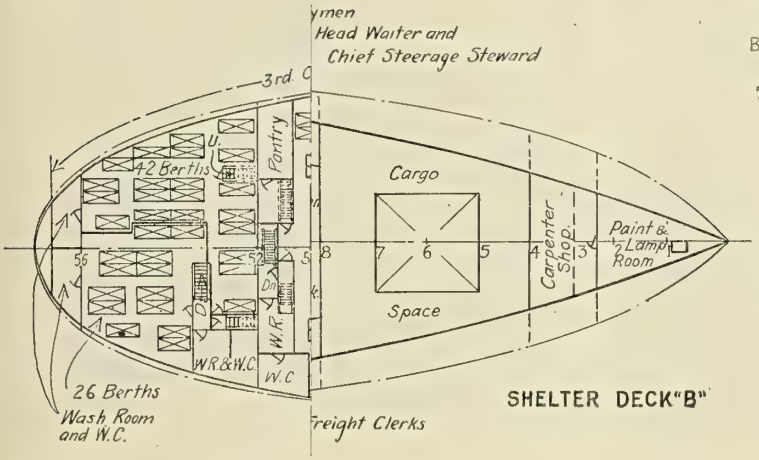
STATE







SECTION THRU PUBLIC ROOMS AT FR. 36



Dimensions:-

Length O.A.	535'-0"
Breadth Mld	72'-0"
Depth Shade Dk.	50'-0"

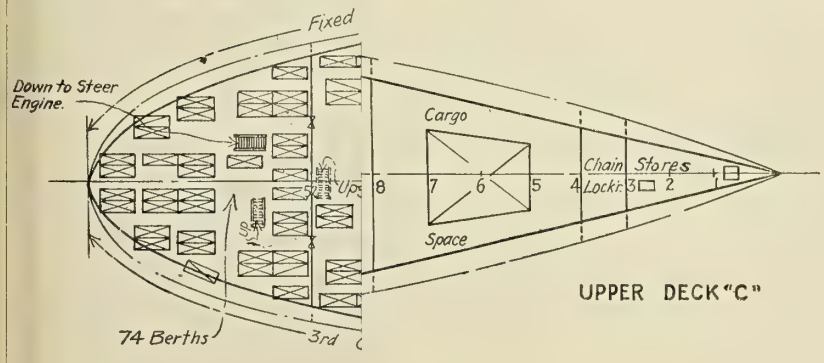
Passenger List:-

1st Class		259
3rd Class		300
	Total	559
Maids		4
	Total	563

Crew List:

Spare Room	10
Deck Dept	42
Eng Dept	45
Stewards Dept	108
Miscellaneous Dept.	4
Total	209
Total	772

Boat Dk { 12 - 26'-0" Life Boats @ 50 Pass. Each 600
2 - 24'-0" Motor Life Boats @ 17 Pass Each 34
Aft Dk House - 3 - 26'-0" Life Boats @ 50 Pass. Each 150
Total 784



Note:-
Doors shown in Bhds Nos 20, 24, 28, 32, 36 & 54 above "C" Dk to be 26" x 60" Hor Sliding W.T. Doors, and to be operated from "B" Deck.
Doors shown in Bhds Nos 12, 16, 20, 28, 32, 36, 40 & 44 above "B" Dk to be 26" x 60" hinged W.T. Doors.

PASSENGER AND CARGO STEAMSHIP HAWKEYE STATE

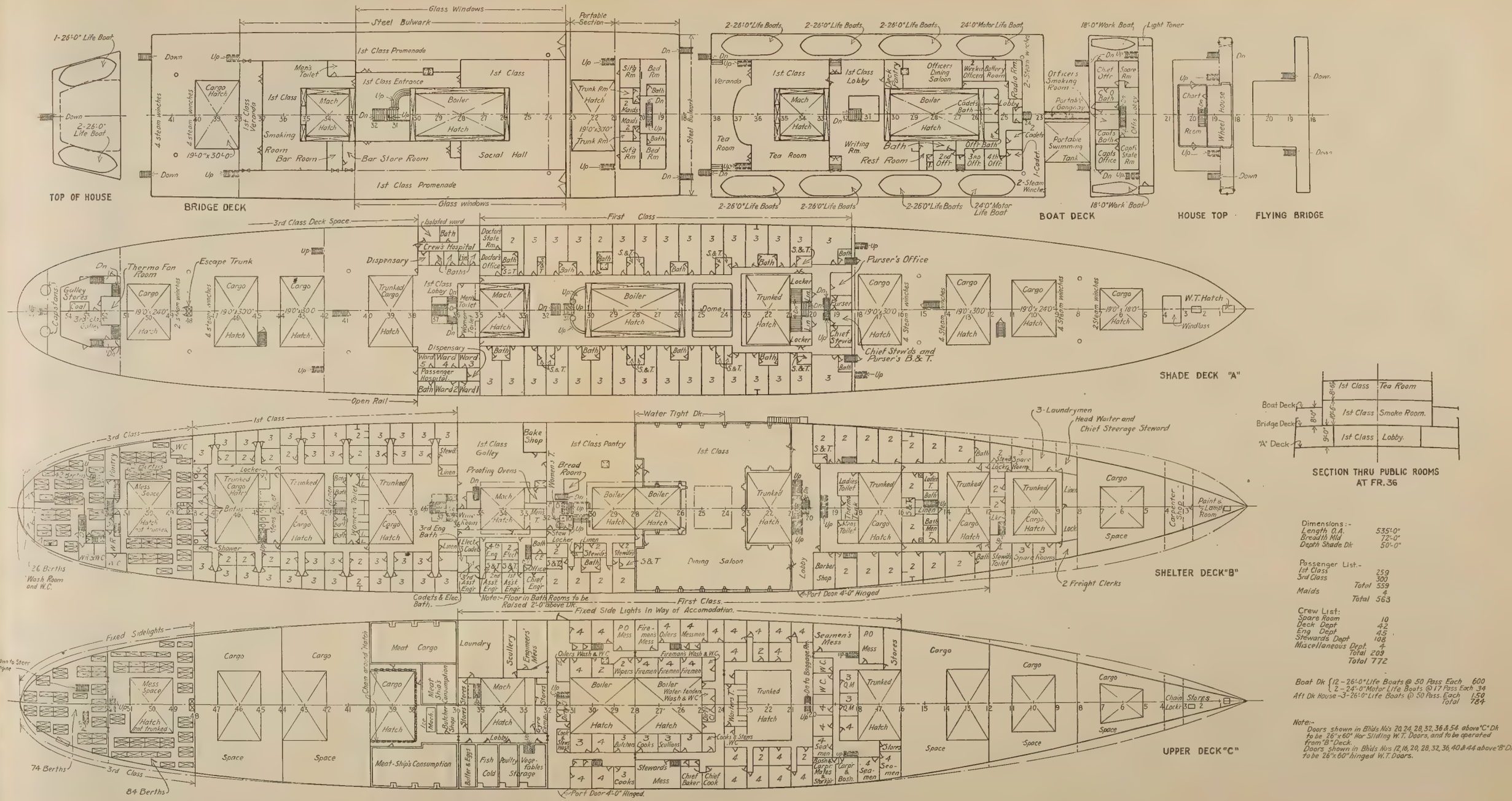
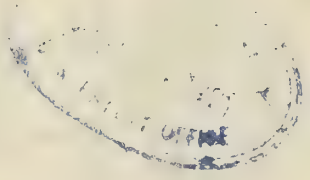

TOP OF HOUSE
BRIDGE DECK
BOAT DECK
HOUSE TOP
FLYING BRIDGE
SHADE DECK "A"
SHELTER DECK "B"
UPPER DECK "C"
SECTION THRU PUBLIC ROOMS AT FR. 36
1st Class Tea Room
1st Class Smoke Room.
1st Class Lobby.
Boat Deck
Bridge Deck
"A" Deck
Dimensions:-
Length O.A. 535'-0"
Breadth Mld 72'-0"
Depth Shade Dk 50'-0"
Passenger List.-
1st Class 259
3rd Class 300
Total 559
Maids 4
Total 563
Crew List:
Spare Room 10
Deck Dept 42
Eng Dept 45
Stewards Dept 108
Miscellaneous Dept. 4
Total 209
Total 772
Boat Dk 12 - 26'-0" Life Boats @ 50 Pass Each 600
2 - 24'-0" Motor Life Boats @ 17 Pass Each 34
Aft Dk House 3 - 26'-0" Life Boats @ 50 Pass. Each 150
Total 784
Note:-
Doors shown in Bhds Nos 20, 24, 28, 32, 36 & 54 above "C" Dk to be 26" x 60" Hor Sliding W.T. Doors, and to be operated from "B" Deck.
Doors shown in Bhds Nos 12, 16, 20, 28, 32, 36, 40 & 44 above "B" Dk to be 26" x 60" Hinged W.T. Doors.

Fig. 12.—Deck Plans



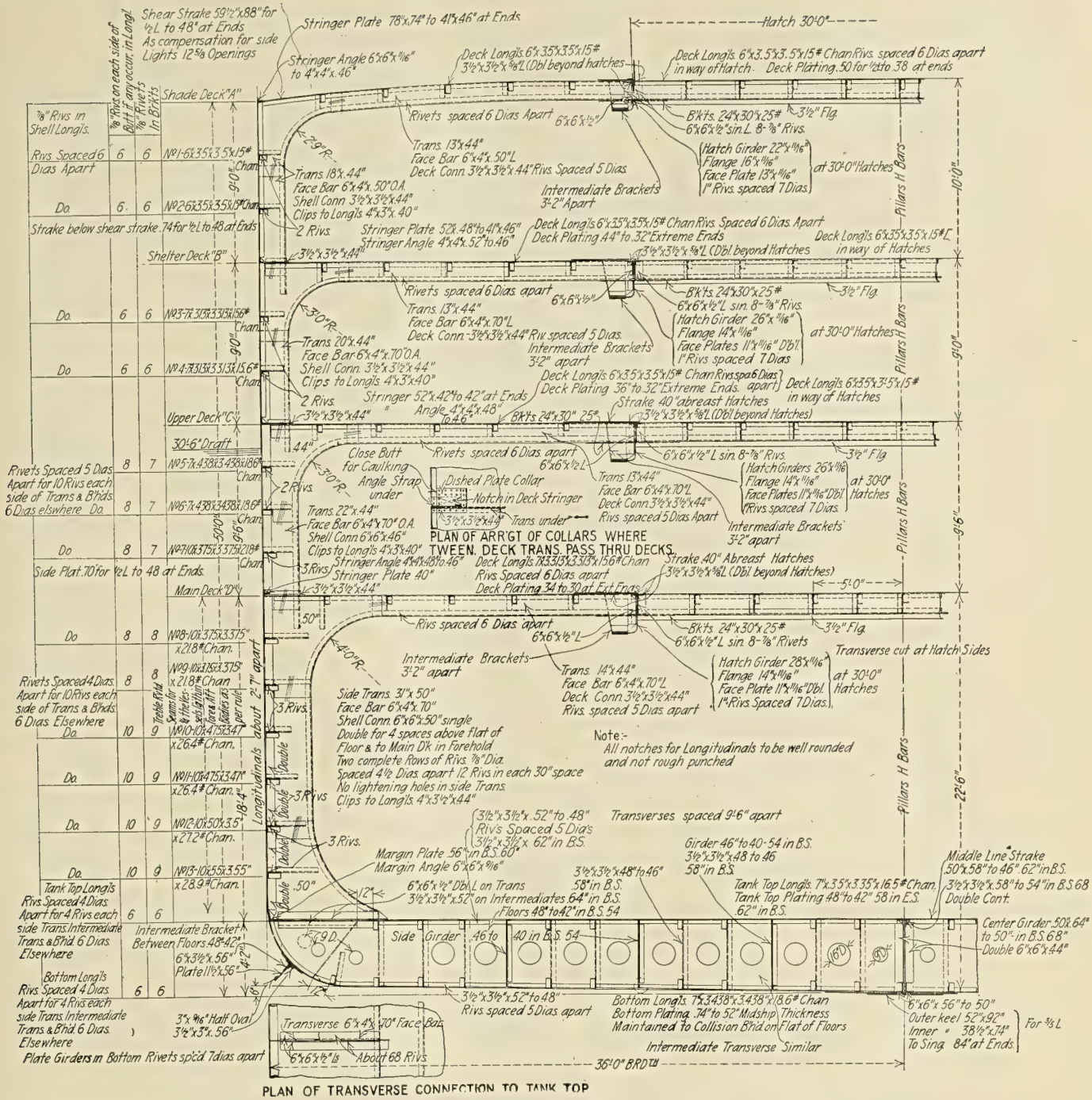

Shear Strake 59½"x.88" for ½L to 48" at Ends As compensation for side Lights 12⅝ Openings
Stringer Plate 78"x.74" to 41"x.46" at Ends
Stringer Angle 6"x6"x11/16" to 4"x4"x.46"
Hatch 30'0"
Deck Long'ls. 6"x3.5"x3.5"x15# Chan Rivs. spaced 6 Dias. apart in way of Hatch. Deck Plating .50 for ½ to 38 at ends
Deck Long'ls. 6"x35"x35"x15#
3½"x3½"x⅜"L (Dbl beyond hatches
Shade Deck "A"
Rivets spaced 6 Dias Apart
6"x6"x½"
B'k'ts. 24"x30"x.25#
6"x6"x½" sin. L. 8-⅞" Rivs.
3½" Flg.
Trans. 13"x.44"
Face Bar 6"x4"x.50"L
Deck Conn. 3½"x3½"x.44" Rivs. Spaced 5 Dias.
Intermediate Brackets 3'-2" Apart
Hatch Girder 22"x11/16"
Flange 16"x11/16"
Face Plate 13"x11/16"
1" Rivs. spaced 7 Dias.
at 30'-0" Hatches
Pillars H Bars
10'0"
2.9 R
Trans. 18"x.44"
Face Bar 6"x4"x.50" O.A.
Shell Conn 3½"x3½"x.44"
Clips to Long'ls 4"x3"x.40"
2 Rivs.
9'0"
Chan
Strake below shear strake .74 for ½L to 48 at Ends
Stringer Plate 52"x.48" to 41"x.46"
Stringer Angle 4"x4"x.52" to .46"
Deck Long'ls 6"x35"x35"x15# Chan Rivs. Spaced 6 Dias. Apart
Deck Plating .44" to .32" Extreme Ends
Deck Long'ls 6"x35"x35"x15#L in way of Hatches
3½"x3½"x.44"
Shelter Deck "B"
Rivets spaced 6 Dias apart
6"x6"x½"
B'k'ts. 24"x30"x.25#
6"x6"x½"L sin. 8-⅞" Rivs.
3½" Flg.
Trans. 13"x.44"
Face Bar 6"x4"x.70"L
Deck Conn. 3½"x3½"x.44" Riv spaced 5 Dias.
Hatch Girder 26"x11/16"
Flange 14"x11/16"
Face Plates 11"x11/16" D'b'l
1" Rivs spaced 7 Dias
at 30'-0" Hatches
30 R
Trans. 20"x.44"
Face Bar 6"x4"x.70" O.A.
Shell Conn 3½"x3½"x.44"
Clips to Long'ls 4"x3"x.40"
2 Rivs.
Intermediate Brackets 3'-2" apart
Deck Long'ls 6"x35"x35"x15# Chan Rivs spaced 6 Dias.
Deck Plating 36" to 32" Extreme Ends. apart
Deck Long'ls 6"x35"x35"x15# in way of Hatches
Stringer 52"x.42" to .42" at Ends
Angle 4"x4"x.48" to .46
Strake 40" abreast Hatches
3½"x3½"x⅜"L (Dbl beyond Hatches)
8'k'ts 24"x30" 25#
Upper Deck "C"
30'-6" Draft
9'6"
Rivets Spaced 5 Dias. Apart for 10 Rivs each side of Trans. & B'hds. 6 Dias elsewhere
Close Butt for Caulking
Angle Strap under
Dished Plate Collar
Notch in Deck Stringer
Trans. under
PLAN OF ARR'GT OF COLLARS WHERE TWEEN. DECK TRANS. PASS THRU DECKS.
Rivets spaced 6 Dias. apart
6"x6"x½"L
6"x6"x½" L sin. 8-⅞" Rivs.
3½" Flg
Hatch Girders 26"x11/16"
Flange 14"x11/16"
Face Plates 11"x11/16" D'b'l
1" Rivs spaced 7 Dias.
at 30'0" Hatches
Trans. 13"x.44"
Face Bar 6"x4"x.70"L
Deck Conn. 3½"x3½"x.44"
Rivs spaced 5 Dias Apart
Intermediate Brackets 3'-2" apart
Trans. 22"x.44"
Face Bar 6"x4"x.70" O.A.
Shell Conn 6"x6"x.46"
Clips to Long'ls 4"x3"x.40"
3 Rivs.
Stringer Angle 4"x4"x.48" to .46"
Stringer Plate .40"
Deck Long'ls 7"x3.5"x3.5"x15.6# Chan
Rivs. Spaced 6 Dias. apart
Deck Plating .34 to .30 at Ext. Face
Strake 40" Abreast Hatches
3½"x3½"x⅜"L (Dbl beyond Hatches)
5'0"
Side Plat. .70 for ½L to 48 at Ends.
Main Deck "D"
Rivs spaced 6 Dias. apart
6"x6"x½"L
8'k'ts. 24"x30"x.25#
6"x6"x½"L sin. 8-⅞" Rivets
3½" Flg.
Intermediate Brackets 3'-2" apart
Trans. 14"x.44"
Face Bar 6"x4"x.70"L
Deck Conn. 3½"x3½"x.44"
Rivs. spaced 5 Dias. apart
Hatch Girder 28"x11/16"
Flange 14"x11/16"
Face Plate 11"x11/16" D'b'l.
1st Rivs. Spaced 7 Dias.
at 30'0" Hatches
Transverse cut at Hatch Sides
Pillars H Bars
22'6"
Rivets Spaced 4 Dias. Apart for 10 Rivs each side of Trans. & B'hds. 6 Dias. Elsewhere
Longitudinals about 2'7" apart
Side Trans. 31"x.50"
Face Bar 6"x4"x.70"
Shell Conn. 6"x6"x.50" single
Double for 4 spaces above flat of Floor & to Main Dk in Forehold
Two complete Rows of Rivs. ⅞" Dia. Spaced 4½ Dias. apart 12 Rivs in each 30" space
No lightening holes in side Trans.
Clips to Long'ls. 4"x3½"x.44"
3 Rivs.
Note:- All notches for Longitudinals to be well rounded and not rough punched
Transverses spaced 9'6" apart
3½"x3½"x.52" to .48" Rivs Spaced 5 Dia's
3½"x3½"x.62" in B.S.
Girder 46" to 40-54 in B.S.
3½"x3½"x.48 to 46
58" in B.S.
Margin Plate .56" in B.S. 60"
Margin Angle 6"x6"x11/16"
3½"x3½"x.48" to 46"
58" in B.S.
6"x6"x½" D'b'l L on Trans
3½"x3½"x.52" on Intermediates 64" in B.S.
Floors 48" to 42" in B.S. 54
Tank Top Long'ls 7"x3.5"x3.35"x16.5# Chan.
Tank Top Plating 48" to 42" 58 in E.S.
62" in B.S.
Middle Line Strake .50"x.58" to 46" .62" in B.S.
3½"x3½"x.58" to 54" in B.S. 68
Double Cont.
Tank Top Long'ls Rivs Spaced 4 Dias. Apart for 4 Rivs each side Trans. Intermediate Trans. & B'hd. 6 Dias. Elsewhere
Intermediate Bracket Between Floors 48" 42"
6"x3½"x.56" Plate 11⅝"x.56"
Side Girder 46 to 40 in B.S. 54
Center Girder .50 .64" to 50" in B.S. 68"
Double 6"x6"x.44"
Bottom Long'ls Rivs Spaced 4 Dias. Apart for 4 Rivs each side Trans. Intermediate Trans. & B'hd. 6 Dias. Elsewhere
3"x.9/16" Half Oval
3½"x3"x.56"
3½"x3½"x.52" to 48" Rivs. spaced 5 Dias. apart
Bottom Long'ls 7"x3.438"x3.438"x18.6# Chan
Bottom Plating .74" to 52" Midship Thickness
Maintained to Collision B'hd on Flat of Floors
Intermediate Transverse Similar
6"x6"x.56" to 50"
Outer keel 52"x.92"
Inner " 38½"x.74"
To Sing. 84" at Ends.
For ⅗ L
Plate Girders in Bottom Rivets spc'd 7 dias apart
Transverse 6"x4"x.70" Face Bar
6"x6"x½" L's
About 68 Rivs
36'0" BRDTH
PLAN OF TRANSVERSE CONNECTION TO TANK TOP

Fig. 13.—Midship Section

which the ship was entered to the forward end of the shade deck house. This stairway is ornamented in gilt and decorated by two sea paintings. At the center is a gilt framed mirror surmounted by a fine Chelsea clock.

Staterooms de Luxe

The twenty-nine staterooms on the shade deck are among the best on the ship. Each has a private bath, in most cases having both tub and shower. The staterooms side of the mahogany bathroom doors have full length mirrors. Two airports in each room provide natural light. The furniture consists of two beds (one folding in behind a panel), a mahogany table, two mahogany bureaus, an upholstered settee berth and a wicker chair. The forward two of these rooms are exceptionally commodious.

Ten passengers can be accommodated in the hospital on the starboard side at the after end of this house.

There are three stairways from the shade deck up to the bridge deck. The forward one leads to the forward bridge deck house, which is given over to two private suites each consisting of sitting room, bed room, bath, maid's room and trunk room. The prevailing cream color is retained in these suites, brightened by window hangings and portieres of old rose.

Public Rooms on the Bridge Deck

The main stairway from the shade deck is between the engine and boiler casings and leads up to the bridge deck entrance hall, and beyond to the boat deck lobby and writing room. The arrangement of the bridge deck entrance forms an alcove on the starboard side and on the port side leads forward to the social hall and aft to the smoking room.

The social hall is unsurpassed by any room on the ship, the cream finish being retained, properly relieved by gold leaf, and old rose and gilt window curtains of velvet. The chairs, sofas, tables, Brunswick talking machine and Steinway grand piano are all of special design in black lacquer.

A fireplace and Wilton rug add to the warmth of this room.

The smoking room is entered on the port side, and tapestry hangings and red and white rubber tile are combined with the prevailing cream color. The furniture is of mahogany upholstered in leather. The doors and windows at the after end open on to a sheltered veranda, while opposite these a fireplace is flanked by two well-stocked bookcases. Over the fireplace is a painting of a full rigged ship and another Chelsea clock. The bar room opens from the starboard side of this room.

The main stairway continues on up to the boat deck under another gilded dome. The natural light possible for this dome shows off with fine effect the mural paintings at each end, one depicting the New York skyline from the Jersey side, the other being a tropical island scene. The lobby at the head of this stairway forms part of the writing room on the starboard side. The chairs and tables are of mahogany, of special design. A well appointed stenographer's desk and built-in book case complete the furnishings of this room. Directly forward of the writing room is a ladies' rest room.

The Tea Room an Attractive Feature

Double doors from both writing room and lobby lead aft into the tea room. The coloring of this room is a departure from the familiar cream, latticing of dark yellow being worked on a putty gray background. The furniture is painted and decorated to match the architecture of the room and English ivy clings to the latticing. Large sofas and a fireplace are attractive features of this room.

The tea room is served from a pantry at the forward end of the boat deck lobby, and looks out at the after end on to another sheltered veranda, which is reached by double doors port and starboard. The architectural features were originated by the staff of the builder's, The Bethlehem Shipbuilding Corporation, Ltd. The interior painting, decorating, carpets and rugs, hangings and specially designed furniture for the public rooms were furnished by Irving & Casson—A. H. Davenport Company, Boston, Mass. Mr. Carrol Bill, artist of this firm, is responsible for the mural paintings.

In addition to the verandas opening from the smoking and tea rooms, which have been mentioned, exceptionally wide promenades flank the bridge deck protected abreast the social and entrance halls by sliding windows of the Laycock type. The boat deck house top aft of the engine hatch provides the largest unobstructed area on the ship and in good weather should prove extremely popular. Between the two bridge deck houses a canvas swimming pool can be erected for the enjoyment of passengers in suitable weather. Shuffle boards, deck quoits and a punching bag give the passengers additional opportunity for outdoor exercise and recreation, and an electric player piano on the bridge deck will furnish dance music.

A companionway from the shelter deck entrance lobby leads down to the first-class passengers' baggage room in No. 5 hold on the lower deck, where are also located the mail and specie rooms and a flour and cereal locker.

Third-Class Quarters

Accommodations for 300 steerage passengers are provided on the shelter and upper decks aft of bulkhead No. 48. These accommodations are divided into four compartments, with a pantry and all toilet and wash spaces on the shelter deck.

All pipe berths and mess tables are portable so that these spaces can be readily converted into cargo holds. This is being done by the Matson Navigation Company on the present cruise.

The entrance to these quarters is from the after shade deck house, which contains the third-class galley and a large room for galley stores.

Officers' and Crew's Quarters

All crew's quarters are fitted with 1⅛-inch tongued and grooved cypress partitions and galvanized pipe berths. The seamen and petty officers are quartered on the upper deck around the trunked hatch to No. 4 hold. Waiters, musicians, etc., are accommodated on this deck over No. 5 hold.

Abreast the boiler hatches the engine and fireroom crew are located on the port side and the stewards' department on the starboard side. The different divisions of the crew have, each adjacent to their quarters, six messrooms on the upper deck. Each messroom has a steam table, tea and coffee urns and an ice chest.

On the shelter deck forward of the first-class quarters, are staterooms for eleven more of the crew and three spare rooms. On this deck, in the first-class quarters, are two inside staterooms for the stewardesses, and abreast the machinery hatch on the starboard side are well appointed quarters for the engineer officers. The chief engineer's office and stateroom are panelled in quartered white oak.

The purser and chief steward are quartered at the forward end of the shade deck house and at the after end of this house on the port side is the doctor and crew's hospital.

The captain and chief officer are quartered in the forward boat deck house, which also contains an officers' lobby and officers' smoking room. These quarters are panelled in quartered white oak. A portable gangway over No. 5 hatch leads from these quarters aft to the forward end of the boat deck house, where are located the remaining officers' quarters, the radio and battery rooms and the officers' mess, which is also panelled in quartered white oak. The latter room accommodates twenty at two tables with swivel oak chairs and, although having dumbwaiter service to first-class pantry, has its own sink, steam table and coffee urns.

Galley and Pantry Equipment

The galley and pantry equipment on this ship are worthy of more than passing comment. The first-class pantry, just aft of the dining saloon on the port side, is equipped with an electric dishwashing machine, automatic egg boiler, electric roll warmer and toaster, 10-foot steam table and a smaller table. The wine room and cold service room open into this pantry. A dumb waiter serves the officers' mess on the boat deck and the mess rooms for engineers and crew on the deck below.

Aft of the pantry is the first-class galley and the bake shop with a dumbwaiter and companion hatch to reach the scullery, butcher shop, messrooms, storerooms and refrigerator spaces below. The oil-burning range has four fires and four ovens. There are two electric bake ovens, a steam proofing oven, electric broiler, steam kettle, stock pot, electric vegetable parer and electric cake mixer.

The third-class galley, in the aft shade deck house, has a coal-burning range, with large coal box in the galley storeroom on the port side of this house.

Cargo Handling Equipment

The detailed description which has been given of the elaborate accommodations for passengers on this vessel should not allow the fact to be lost sight of that this ship is primarily a cargo carrying vessel, having a capacity of about 8,000 tons of cargo in the holds. The facilities providing for expeditious loading and unloading of this cargo are unusually complete, the absurdity of combining the speed of this ship with long periods of lost time for cargo handling being kept in mind.

Heating and Ventilation

Details of the cargo booms, winches, windlass, steering gear and other deck machinery, including the life saving equipment, will be found on page 190.

Throughout the first-class quarters, heating and ventilating

are accomplished to a great extent by a combined thermotank system, using Sturtevant blowers and Schutte-Koerting thermotanks. The same system is used for the third-class quarters.

The capacity of this system is designed to heat all public rooms to 70 degrees F., and is also capable of delivering cold air when desired. In the staterooms, this system is to heat to 50 degrees F., and electric heaters concealed behind grills may be used to make up the deficiency when required.

First-class passages, public toilet spaces and all crew spaces are heated by steam radiators. Ample natural ventilation is supplied for the cargo holds by means of cowl vents.

In addition to the usual natural ventilation for the engine room, two 2,400 cubic feet per minute blowers supply air to the engineers' workshop, motor generator room, and refrigerating machinery room, which are located on flats under the upper deck.

The hot fresh water system is so arranged as to keep the water constantly circulating through the pipes, a small automatically controlled pump in the engine room returning the water to the hot fresh water tank in the boiler casing. Hot fresh water is supplied to first-class passengers' showers and lavatories and officers' lavatories. Hot salt water is supplied to first-class passengers' bath tubs, officers' and crew's showers, and slop sinks. Cold fresh water is supplied to first-class passenger showers and lavatories, officers' lavatories and sinks in third-class quarters. Cold salt water is supplied to first-class passengers' tubs, officers' and crew's showers, crew and third-class lavatories.

Ice water is piped to the crew's and officers' mess rooms and to six white metal drinking fountains in the first-class lobbies.

The plumbing throughout is of first quality and many of the fixtures are of special design, all being supplied by A. B. Sands and Son Company, New York.

Refrigerating Plant

The refrigerating plant is located on a flat on the starboard side of the engine room and is supplied complete by the York Manufacturing Company, York, Pa. There are two fifteen-ton twin cylinder CO_2 machines, with all necessary pumps, coolers, etc. On the upper deck is an ice-making machine with a capacity of 1,000 pounds of ice per day.

The ship's meat rooms are located on the upper deck over hold No. 6, and are cork insulated with tile flooring. The cargo meat room of 4,032 cubic feet capacity is on the port side, and two provision meat rooms contain 6,021 cubic feet. In addition are the following cold storage spaces: Butter and eggs, 665 cubic feet; fish, 1,140 cubic feet; poultry, 980 cubic feet; vegetables, 1,405 cubic feet. In addition to the upper deck cold storage spaces, large built-in refrigerators in the first-class pantry, wine room and bar room are also cooled by brine pipes from the refrigerating plant.

A modern laundry on the port side of the upper deck contains a motor-driven washing machine, extractor, flat ironer, and tumbler dryer, and an electric skirt iron table. This outfit was supplied by the Troy Laundry Machine Company, Troy, N. Y.

The Rich fire extinguishing system is installed in the cargo holds, with detector cabinet in the pilot house and two control cabinets on the shade deck. The first-class staterooms and crew spaces are protected by the Aero fire alarm system, with indicators in engine room and pilot house.

Pneumercators are installed in the wing fuel oil tanks abreast the boiler rooms and an automatic alarm indicates when these tanks are filled.

Electric Plant

The electrical equipment on this ship is supplied from four 50 kilowatt, 115-volt compound wound General Electric Company generators, driven by Terry steam turbines, and operating at 250 pounds steam pressure. A 5-kilowatt gasoline engine-driven emergency generator set is located in a house on the starboard side of the boat deck house top.

The main switchboard, of 7 panels, is of Bethlehem manufacture and contains all the necessary switches and apparatus for control of the generators and distribution of ship's service. Approximately 1,800 lights are installed on the ship. Cargo lights are located on brackets on each side of each kingpost, and twelve cluster lights of six lamps each are provided for the holds.

A Sperry gyro compass outfit is installed, with a master compass on the upper deck connected to three steering repeaters and two peloruses.

Propelling Machinery

The two main driving units consist of Curtis marine type impulse turbines made at the Fore River Plant of the Bethlehem Shipbuilding Corporation, Ltd., operating through a two-pinion single-reduction gear supplied by the Falk Company, Milwaukee, Wis. One pinion connects to the high pressure turbine through a flexible pin coupling and the other pinion connects to the low pressure and reverse turbines, which are built into the same casing, in like manner. When the throttle is provided with steam at 250 pounds gage and 75 degrees F. superheat and a vacuum of 28 inches is maintained in the low pressure turbine exhaust, this unit will develop over 6,000 shaft horsepower at 125 revolutions per minute, and consume 10 pounds of steam per shaft horsepower per hour.

The Turbines

The turbines are of the multi-stage impulse type and are made up of a number of wheels, each running in a separate compartment. The clearances between the stationary and moving parts are made large enough to avoid all danger of their striking and without loss of efficiency. Leakage of steam between the diaphragm and shaft is prevented by the use of labyrinth packing rings of soft composition.

The high pressure turbine, which consists of one two-row stage and eleven single-row stages, measures 6 feet 3½ inches between centers of bearings and has a maximum diameter of 5 feet 3 inches. The low pressure turbine has seven single-row stages and the reverse turbine has two two-row stages. These two turbines have a common casing and shaft. Their combined length between bearing centers is 6 feet 5½ inches and their maximum width measures 8 feet 4 inches.

Each turbine casing is divided into four sections by a horizontal and a vertical joint; which are carefully machined and scraped and made up without packing. Cast steel is used in the steam inlet end of the high pressure turbine to withstand the high steam pressure and superheat in the steam chest, which is in the upper half, without excessive weight. The other casings are made as light as practical, of close grained cast iron, and are heavily ribbed for strength.

Thirty percent of the first stage ahead steam nozzles are controlled by two valves built into the steam chest. The operation of these valves maintains greater efficiency at low speeds. The astern steam chest is contained in the upper half of the back end of the low pressure casing and is made strong enough for full boiler pressure by increasing the wall thickness above the rest of the casing.

In order to secure the best possible alinement and to render the casings as rigid as possible the bearing pedestals have been made as part of the lower half casings. Ample openings are provided for steam inlets to all the steam chests and for the exhausts from both casings, and drain connections are provided wherever necessary.

The nozzles are of two styles, the machined and the cast-in. The first stage high pressure and astern nozzles are expanding nozzles of the machined type and are made by drilling and reaming holes at the proper angle and correct location in

monel metal plates, bolted to the steam chests. The other stage nozzles, which, excepting the second stage astern, are non-expanding, are cored openings in the cast-iron diaphragms or nozzle plates with nickel steel blades cast in at the best angle and distance to divide them into correctly formed nozzles. All cast-in nozzles are filed smooth and carefully to size for high efficiency.

The diaphragms which form the walls of the stage compartments are made of close grained cast iron properly designed to withstand the pressure difference between the adjacent stages.

The turbine wheels are high grade open hearth steel forgings carefully designed for low stresses and smoothly finished to reduce the windage losses. They are shrunk on the shaft and are also keyed with steel keys and are grooved at the periphery to take the blade roots. Vent holes in webs are provided to overcome slight unbalance in steam pressure between front and back of wheel.

The turbine shafts are accurately machined steel forgings so proportioned that their critical speeds are well above the running speeds. They are fitted with removable labyrinth packing sleeves, thrust collars, squealer rings, worms for governor drive, and keys for the wheels and couplings.

The turbine buckets are made of non-corrosive material, capable of withstanding exceptionally high stresses. Each bucket is made true to gage, having a dovetail shaped root which fits accurately into a channel of the same section, machined in the rim of the wheel. A shroud ring is riveted to the outer ends of the buckets, and made 1/32-inch wider than the bucket section, this excess being all on the steam inlet side of the bucket. The stationary intermediate buckets between two moving rows of the double row wheels are made and assembled in a similar manner to the buckets of the wheels.

The turbine bearings are 7 inches by 9 inches of the shell type. They are of cast-iron lined, with high grade babbitt metal bored and scraped to size. The shells are of spherical form split for easy removal and supplied with large oil connections. The thrust bearing and squealer ring housings are cast with the forward bearing shells for easy alinement, and composition packing rings are fitted to the bearings and their cast iron covers to prevent loss of oil.

Between the ends of the turbine casings and shafts, the steam packing and sealing stuffing boxes are of the labyrinth type and consist of soft composition rings, which fit snugly to labyrinth sleeves shrunk on the shafts.

Double thrust bearings of the Kingsbury type are fitted to the forward ends of the turbine and reduction gear shafts. They take the unbalanced turbine or propeller thrusts in both directions. These bearings are of steel with composition shoes and are plentifully supplied with oil under pressure.

Brass squealer rings made in halves are fitted into grooves provided in the forward bearing shells of each turbine to give warning when the wheel clearances become too small.

The turbine micrometer is located at the end of each turbine shaft accurately to check the blade clearances. This consists of a steel pin operated by a lever which moves over a graduated scale and by which it is moved up until it touches the end of the shaft.

A pin coupling transmits power between each turbine and its reduction gear pinion. A flange is carried on each of the adjacent ends of these shafts. Twelve hardened steel pins are firmly bolted into one of these flanges and are inserted into holes in the other flange.

The turning gear consists of a removable ratchet wrench which fits the squared end of the reduction gear pinion shaft.

Governors

Constant acting, non-tripping speed control governors are mounted at the forward end of each turbine, and are driven by steel worms on the turbine shafts. These governors, which are of the centrifugal type, operate pilot valves which regulate the main steam governor. Easy and rapid operation is secured by ball bearings, excellent lubrication and light moving parts. The governor valve is of cast steel with a monel metal valve disk and seat.

The cross connection pipes between the turbines are of copper and are provided with valves so that in normal operation the high pressure turbine exhausts into the steam inlet end of the low pressure turbine. In case of accident to the low pressure turbine, the high pressure turbine can exhaust direct to the main condenser. Provision is also made so that in case of accident to the high pressure turbine steam from the main steam line can be directed into the low pressure turbine.

Lagging of magnesia blocks held in place with wire and covered with sheet steel plates is used on the high pressure turbine and the high pressure ends of the low pressure turbine to minimize the radiation losses. The horizontal casing joints are fitted with removable plates and bags of magnesia are used instead of the blocks to facilitate overhauling.

Maneuvering Valves

The maneuvering valves are of the quick operating, balanced, single port type and both ahead and astern valves are operated by the same handwheel. When the operating handwheel is in mid-position both valves are closed. The ahead throttle valve is opened by turning the handwheel to the left and the astern throttle valve by turning the handwheel to the right. The handwheel must always be brought back to neutral position in closing one valve and opening the other, so that both valves cannot be open at the same time. The maneuvering valve body is of cast steel and the valve disks and seats are of monel metal to withstand the high pressure and superheat.

A cast steel steam strainer with a removable monel metal basket is placed in the main steam line just before the governor valve to prevent any foreign material entering the turbine.

Reduction Gears

The reduction gears are of single reduction, double herringbone type with the gear and two pinions all in one horizontal plane. The gears are of cast steel, split horizontally at the hub to eliminate shrinkage strains. The rims, arms and hubs are cast in one piece and carefully annealed and machined. They are firmly secured to the shaft to insure accurate alinement. The gear shafts are steel forgings supported by two bearings of the shell type, lined with babbitt metal and are each fitted with a removable thrust bearing collar at the forward end.

The pinions are of chrome nickel steel accurately machined and are each supported by three bearings of the babbitt-lined shell type. They are carefully proportioned to secure equal distribution of tooth pressure by minimizing the cross bending and torsional deflection.

The cast-iron frame has been carefully shaped and ribbed to secure rigidity and reduce vibration and noise. The oil pans below the gears are of cast iron and the gear case covers are of sheet steel suitably lined to reduce noise. Hand holes are provided for access to the pinions and gears and for observing the lubrication.

Lubricating System

The gears and pinions, when running either ahead or astern, are lubricated at their points of contact by sheets of oil sprayed from oil sprays. The sprays are connected to an external manifold and may be removed together with the manifold, for cleaning, without lifting the gear case cover. The astern sprays are controlled by valves so that they may be cut off at all times except when ship is maneuvering.

All parts of the turbines and reduction gears requiring

(*Continued on page* 211.)

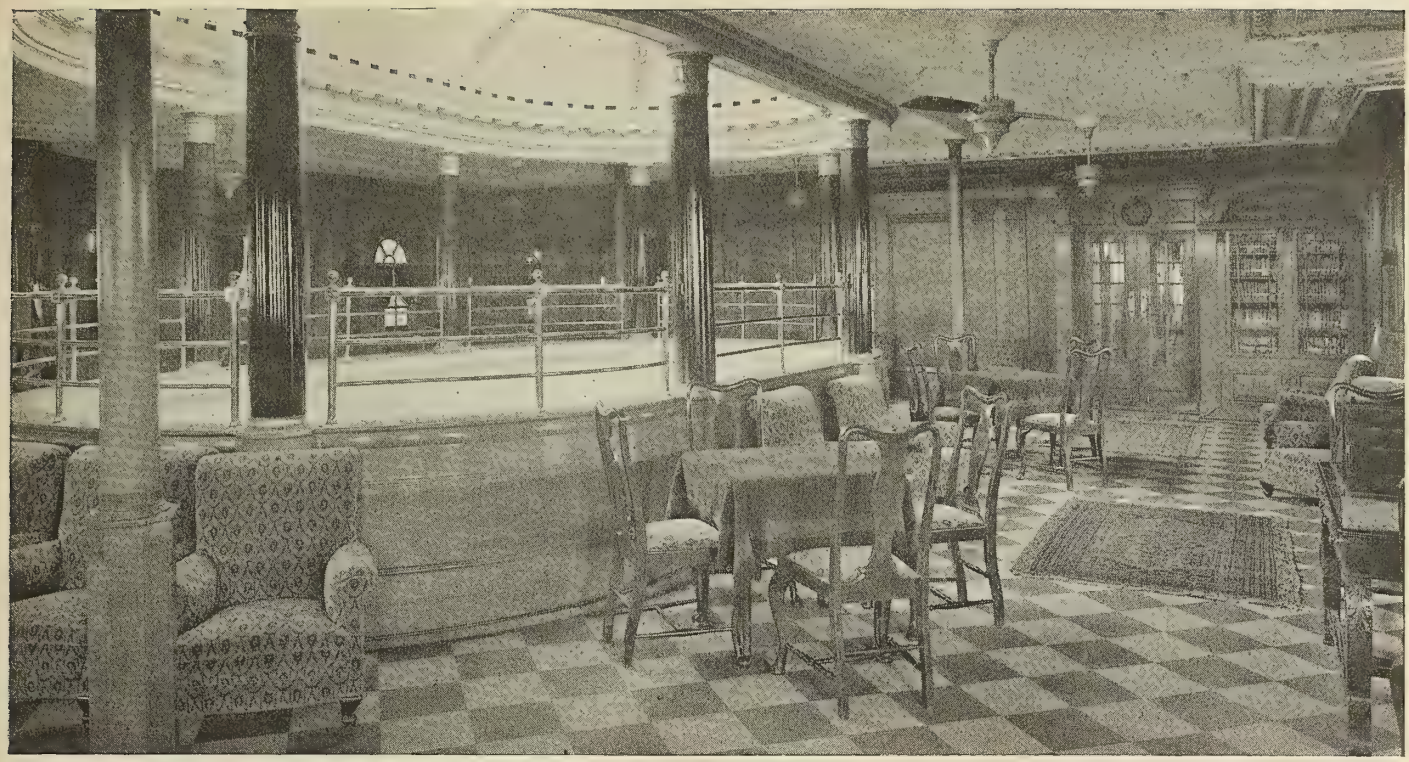


Fig. 1.—Music Saloon, Looking Aft, on S. S. *Naldera*

The P. and O. Liner Naldera

New Passenger and Mail Steamer Built by Messrs. Caird & Company for India and Australian Service

THE steamship *Naldera,* which was designed and built by Messrs. Caird & Company, Limited, Greenock, Scotland, for the passenger and mail service to India and Australia of the Peninsular & Oriental Steam Navigation Company, is one of the largest and most modern units of the fleet of that company. Her keel was laid in 1914, but construction was suspended on account of the war. Two years later work was resumed and she was launched in December, 1917. The vessel was first completed as a cargo carrier in 1918, and afterwards fitted out as a troopship and armed cruiser, but was never used for either of these services. After the conclusion of the armistice she was restored to her owners for completion along the lines originally intended. She was completed early in 1920 and made her maiden voyage in April of that year.

Of the three-stack cruiser stern type, the *Naldera* is designed for a speed of 18½ knots. Five of her decks, viz., the orlop, lower, main, upper and hurricane decks, extend the full length of the ship, while above these are the promenade and boat decks, each of which has a length of 440 feet and projects 2 feet 6 inches beyond the molded breadth of the vessel, as shown on the midship section. This provides additional space for promenades. Expansion joints are provided amidships in these two decks.

Accommodations are provided for first and second class passengers only. Most of the accommodations are in one, two, three and four berth staterooms, with a few special suites consisting of sitting room, bedroom and bath. All staterooms have lavatories with running water.

Two electric lifts are provided forward, which operate between the main and promenade decks, with landings at the intermediate decks.

On the main deck are the first and second class dining saloons and galleys, and some second class staterooms. First and second class staterooms occupy the greater part of the upper deck. On the hurricane deck are first class staterooms and the second class smoking room and music room. On the promenade deck are the gymnasium, first class music room, companion and divan, smoking room and verandas, and also some first class staterooms. Officers' quarters are provided on the boat deck. Some unusual features of these quarters are the veranda, promenade and smoking room provided for the engineer officers.

Cargo is carried in four holds forward and two holds aft. Two of the forward holds are fitted for carrying refrigerated cargo. Space is provided aft for mail and baggage. The cargo is handled entirely by hydraulic cranes, the power for which is furnished by a pump and hydraulic accumulator in the engine room.

The vessel is driven by two quadruple expansion reciprocating engines. Steam is supplied by ten coal-burning Scotch boilers operating under the Howden system of forced draft. The ashes are discharged through the bottom of the ship by two Stone hydraulic ash expellers. An ash hoist is also provided in each boiler room.

The electric generating plant consists of six compound engines, driving generators having a total output of 280 kilowatts at 105 volts. The electric installation includes some 3,000 lamps and over 800 cabin fans, as well as electrically operated lifts, galley machinery and gymnasium appliances. A 15-kilowatt oil engine driven emergency generating set is fitted on the promenade deck.

The *Naldera* is now operating between England and India and Australia and is giving excellent service. A sister ship, the *Narkunda,* has been completed at the Belfast yard of Harland & Wolff and will also operate between England and the British colonies of the southern hemisphere, carrying passengers, cargo and mail.

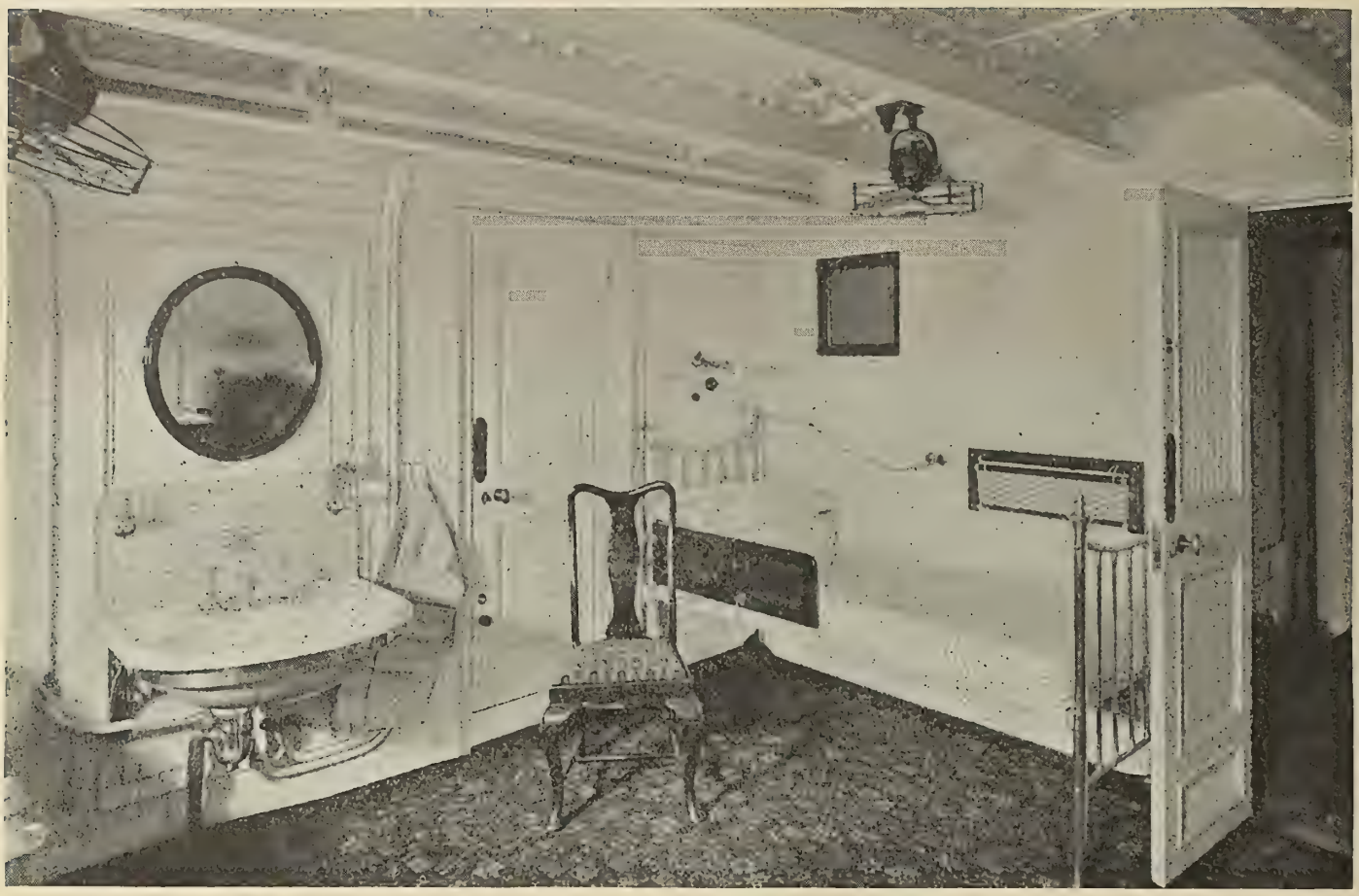


Fig. 2.—First Class Cabin

Fig. 3.—Main Lobby, Looking Aft

Fig. 4.—First Class Dining Saloon, Dome from Gallery

Fig. 5.—First Class Dining Saloon, Looking Forward

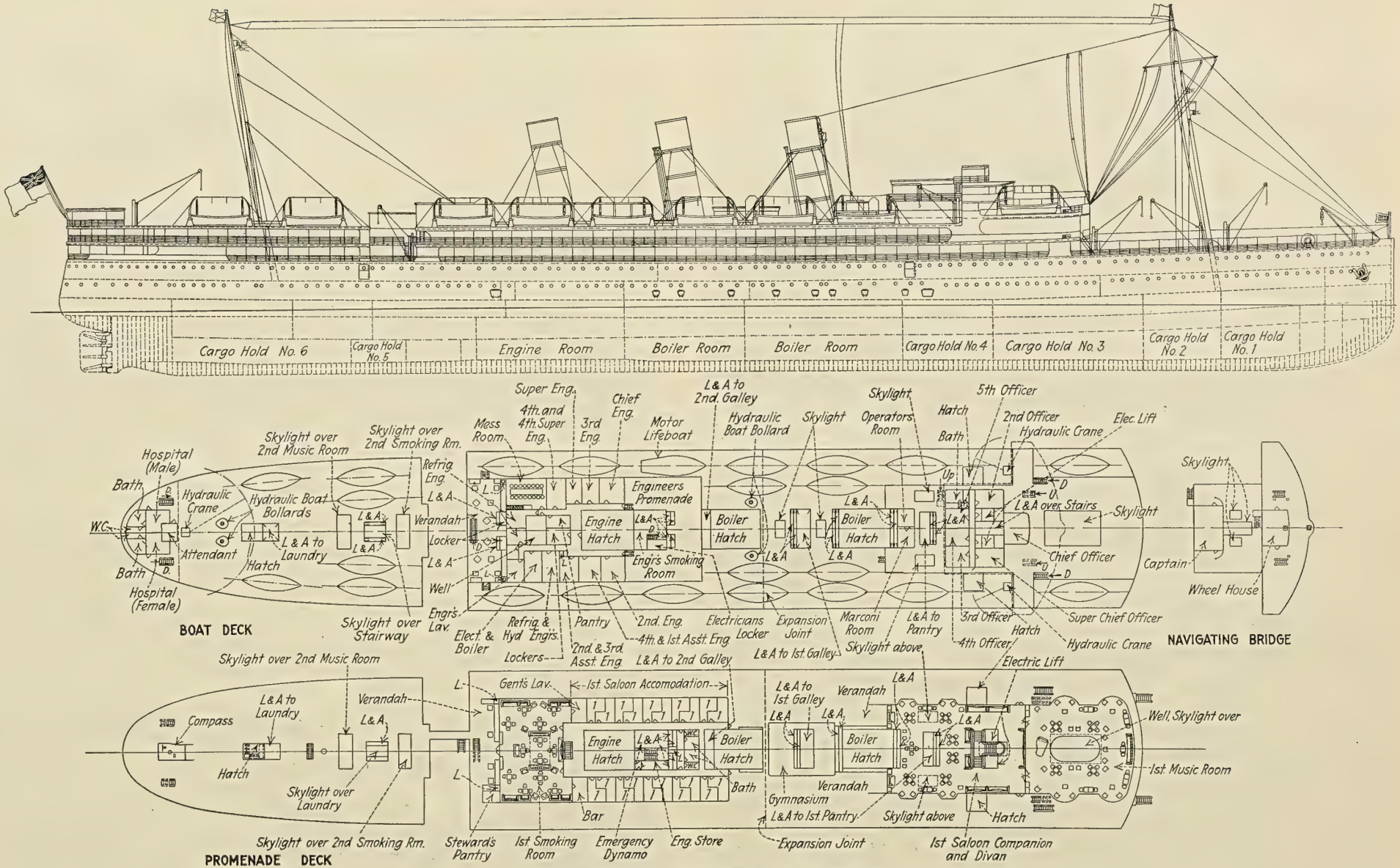


Fig. 6.—Profile and Deck Plans, S. S. *Naldera*

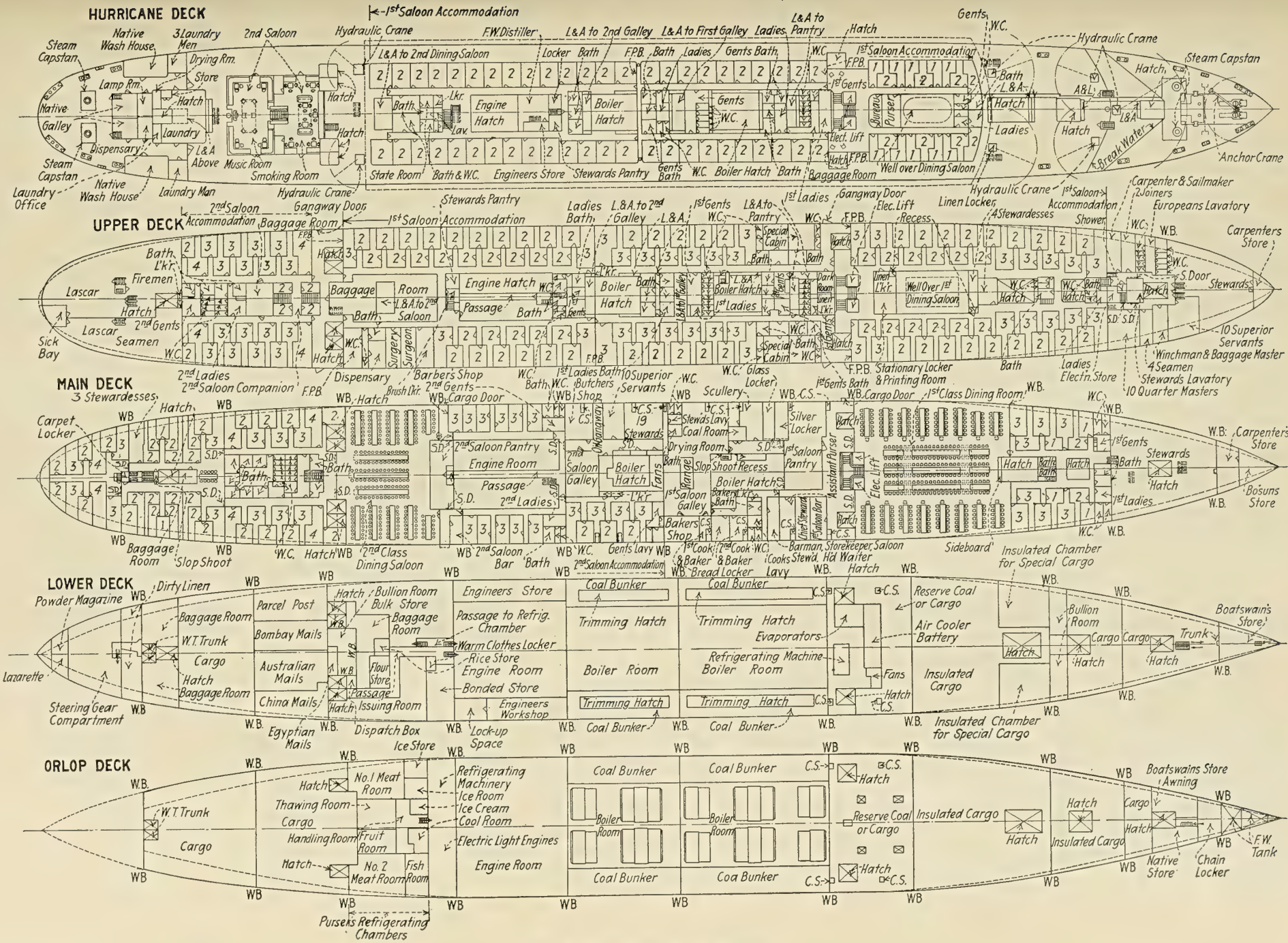


Fig. 7.—Deck Plans, S. S. *Naldera*

Peninsular and Oriental Liner Naldera

General Information

Service: Passenger and freight, England to India and Australia.

Builder: Messrs. Caird & Company, Greenock, Scotland.

Owner: Peninsular and Oriental Steam Navigation Company, London, Eng.

Characteristics

Length, overall .....605 feet
Length, B. P. .....581 feet
Beam, molded .....67 feet
Depth, molded, to upper deck.....40 feet 9 inches
Depth, keel to navigating bridge....77 feet
Draft, loaded .....29 feet 6¾ inches
Draft, light .....
Block coefficient .....
Midship section coefficient .....
Longitudinal coefficient .....
Speed, loaded, knots.....18½
Cruising radius, nautical miles.....
Framing .....Transverse
Class .....

Tonnages

(In tons of 2,240 pounds)

*Weight of hull.....
**Weight of propelling machinery.....
Deadweight capacity .....
Displacement .....

(In tons of 100 cubic feet)

Gross register 15,825
Net register .....

* Weight of hull includes hull proper, hull fittings, equipment and outfit.
** Weight of propelling machinery includes engines, boilers (wet), shafting, propellers and machinery space auxiliaries.

Canal Ratings

(In tons of 100 cubic feet)

Suez .....
Panama .....

Complement

Deck officers .....
Deck crew .....
Engineer officers .....
Engineer crew .....
Purser's and steward's department.....

Total officers and crew..... 462
First-class passengers 426
Second-class passengers 247

Total passengers 673
Total complement 1,135

Handling Equipment

	No. Type	Capacity	Length
Masts	2 Pole		135 feet above L. W. L.
Derrick posts	None		
Booms	None		
Discharging capacity			

Deck Machinery

Steering gear.....Steam tiller, telemotor controlled, hydraulic auxiliary gear.
Windlass (1) .....
Capstans (4) .....steam
Cranes (10) .....hydraulic
Boat bollards (4).....hydraulic

Life Saving Equipment

	No. Type	Length
Lifeboats	23 1 motor	

Propelling Machinery

Boilers

Number 10
Type ..4 dbl. ended; 6 single ended Scotch
Length .....double ended, 20 feet
single ended, 11 feet 9 inches
Diameter.....double ended, 16 feet 6 inches; single ended; 15 feet 2 inches
Furnaces.....8 in each D. E.; 3 in each S. E.
Fuel .....Coal
Draft .....Forced
Total heating surface....39,628 square feet
Total grate surface..... 958 square feet
Superheat, degrees F. .....
Working pressure, pounds per square inch 215
Normal fuel consumption:
Per day, tons .....
Per horsepower hour, pounds.....
Normal steam production:
Per hour per pound of fuel.....
Total per hour .....

Engines

Number 2
Type....Quadruple expansion reciprocating
Size.....32½ inches, 46½ inches, 67 inches and 96 inches, by 50 inches.
Horsepower, total indicated.....15,000

Propellers

Number 2
Type.....3-bladed, manganese bronze
Weight .....
Diameter .....19 feet
Pitch .....24 feet
R. P. M. 90
Projected area .....
Developed area, each....278.25 square feet

Auxiliary Machinery

Refrigerating Machinery

1 Haslam CO_2 unit for cargo
1 Haslam CO_2 unit for stores

Engine Room

Condensers.....2 main, Weir "Uniflux;" cooling surface, 7,500 square feet, each.
1 auxiliary, 953.35 square feet cooling surface, Caird & Co.
Evaporators.....2-40-ton Weir
Distiller .....
Filters..1 main feed, double for 6-inch pipe
1 auxiliary feed, for 3-inch pipe
Feed water heater..1 Weir, 32-inch, direct contact
Pumps
2 Tangye's centrifugal circulating, impeller pipe 22 inches; engine 13 inches by 11 inches.
2 Weir dual air, 15 inches by 26 inches by 18 inches.
1 Weir bilge, 10½ inches by 13 inches by 24 inches.
1 Weir sanitary 10½ inches by 13 inches by 24 inches.
1 Weir ballast, 10½ inches by 13 inches by 24 inches.
3 Weir main feed, 20 inches by 14 inches by 32 inches.
1 Weir auxiliary feed, 9½ inches by 7 inches by 18 inches.
1 Weir fresh water.
1 Hydraulic air and circulating
1 Waste oil.
Accumulator....1 Brown Bros. hydraulic; ram, 12 inches; stroke, 5 feet 6 inches; pressure, 1,000 pounds per square inch.
Hydraulic pumping engine..1 Brown Bros.
Air extractor.....1 Hallet, 6-inch pipe
Float tank.....1 Caird & Co.
Vent fans.....2 Howden, 42-inch
Steam separator.....2 Caird & Co.
Turning engine.....2 Caird & Co., 8 inches by 8 inches.

Electrical Equipment

Generators.....6-45 K. W. Belliss-Morcom
1-15 K. W. emergency, oil engine driven.
Lamps, number 3,000
Cabin fans, number..... 800
Radio set

Boiler Rooms

Forced draft fans.....4 Howden, 78-inch
Vent fans.....2 Howden, 42-inch
Ash expeller.....2 Stone
Ash hoist....1 Alley & McCellan, engine 4-inch by 5-inch

Holds

No.	Length	Hatches
1	34'8"	12'0" x 9'0"
2	34'8"	12'0" x 11'0"
3	65'0"	18'0" x 12'0"
4	39'0"	(2) 9'0" x 8'0"
5	26'0"	(2) 9'0" x 6'6"
6	78'0"	9'0" x 7'0"

Capacities

Cargo Space

Compartment	Cu. Ft.
No. 1 Cargo Hold	
No. 2 " "	
No. 3 " "	
No. 4 " "	
No. 5 " "	
No. 6 " "	
No. 4 lower 'tween decks (coal or cargo)	
No. 5 " " "	
No. 6 " " "	
No. 1 upper 'tween decks	
No. 2 " " "	
No. 4 " " " (coal or cargo)	
No. 6 " " "	
No. 1 Hach trunk	
No. 2 " "	
No. 3 " "	
No. 4 " "	
No. 5 " "	
No. 6 " "	
Total cargo space	253,320

Refrigerated Space

	Cu. Ft.
Total refrigerated cargo space.....	103,360
Refrigerated space for ships' use..	15,670
Total	119,030

Bunkers

Compartment	Cu. Ft.	Tons
Forward side bunker, port		
" " " starboard		
Aft " " port		
" " " starboard		
Total permanent bunkers		2,940
No. 4 lower 'tween decks		
No. 4 upper " "		
Total bunker space		

Tanks

Compartment	Cu. Ft.	Tons F. W.	Tons S. W.
Fresh Water Tanks.....		886	
Ballast Tanks.....			1,890
Total		886	1,890

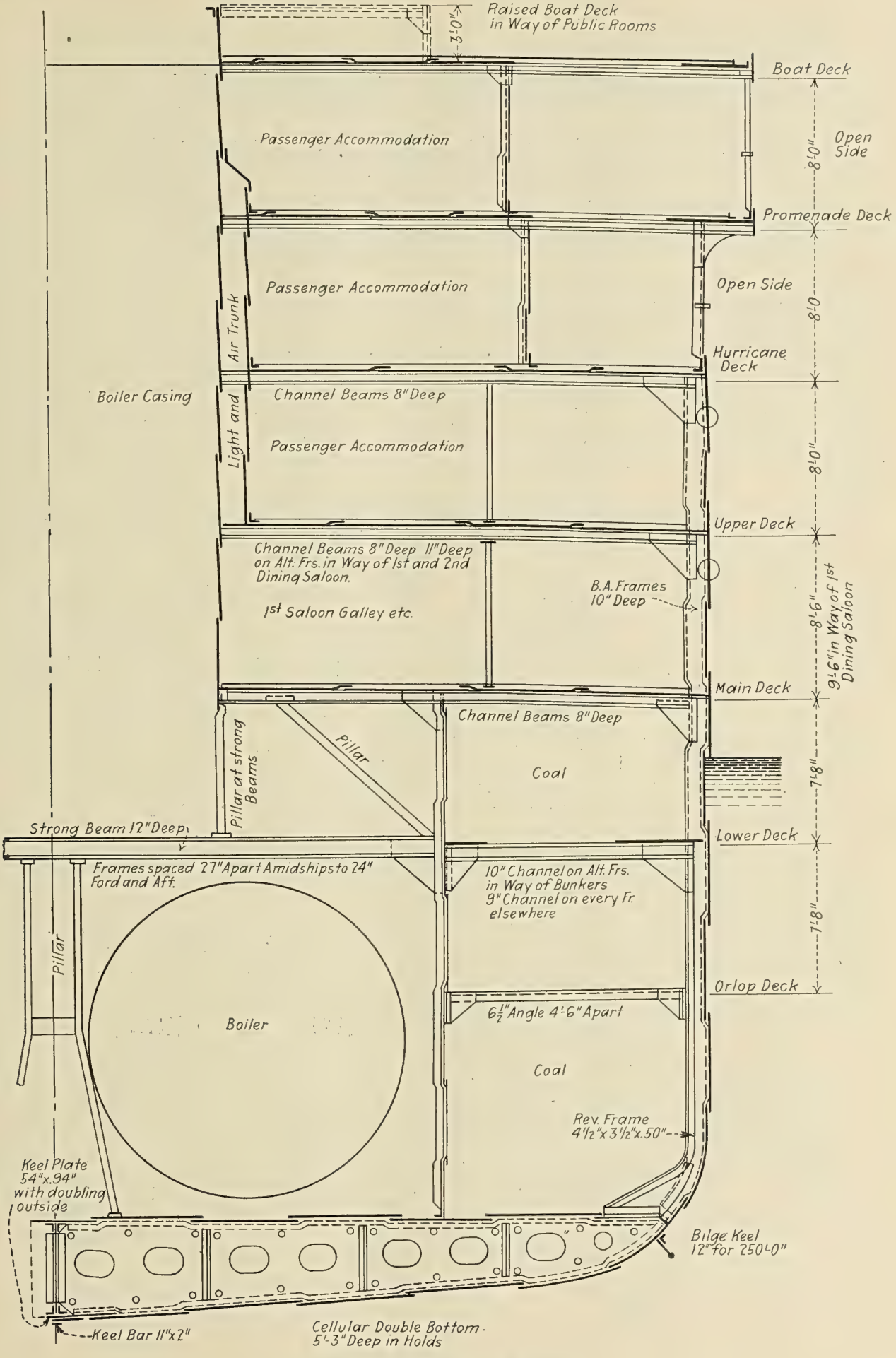


Fig. 8.—Midship Section, S. S. *Naldera*

Mail and Passenger Steamer Naldera

ARRANGEMENT OF MACHINERY AND PIPING

LIST OF ENGINE ROOM PIPES

Pc. No.	Size	Material	Material
1	13 "	W. I	Main Steam to Engines
2	9½"	W. I	" " " Cross Conn.
3	12½"	W. I	" " " Engines P. & S.
4	6 "	C. I. Valve	" " " Aux.
5	6 "	SDS & No.1 Copp.	Aux. Steam to Aux. P. & S. (Ford. Bhd.)
6	6½"	" "	" " " " Stb. Side
7	5¾"	S. D. Steel	" " " " "
8	4¼"	SDS & No.4 Copp.	" " " " Aft. End
9	6 "	S. D. Steel	" " " " Port Side
10	5¾"	"	" " " " " "
11	4 "	"	" " " " Hydr. Accum.
12	1¼"	No. 9 Copp.	" " " " Aux. Feed Pump (Direct)
13	1¼"	"	" " " " " " (Control)..
14	3¼"	S. D. Steel	" " " Steering Eng.
15	3¼"	Copp...	Main Steam to St. Eng. from D. E. Boiler
16	1½"	S.D . Steel	Aux. Steam to Hydr. Air & Circ. Pump
17	2½"	"	" " " " Main Feed Pumps Ht. Con
18	2½"	"	" " " " " " Tank Con.
19	1¾"	"	" " " " Ballast Pump
20	1¾"	"	" " " " San. Pump (Direct)
21	1¾"	No. 9 Copp.	" " " " " " (Control)..
22	1¾"	S. D. Steel	" " " " Air Pump P. & S.
23	1¾"	"	" " " " Bilge Pump
24	2¾"	"	" " " " Evap. (Combined)
25	2 "	"	" " " " Evap.
26	1¼"	No. 9 Copp.	" " " " Turning Eng. P. & S.
27	3½"	S. D. Steel	" " " " Circ. Pump P. & S.
28	2½"	"	" " " " Aft. Refr.
29	1½"	"	" " " " Fire Pipes
30	½"	Copper	" " " " Waste Oil Pump
31	2½"	SDS & No.7 Copp.	" " " " Generating Sets
32	¾"	No. 10 Copp.	" " " " Fresh Water Pump Direct
32A	¾"	"	" " " " " " " (Contro)
33	½"	Copp.	" " " for Cleaning Main Feed Filters
34	½"	"	" " " " " Aux. Feed Filter
35	2¼"	"	" " " to Pantries
36		"	" " " " Distillers and Bath Heater
38	¾"	No. 10 Copp.	" " " " Hyd. Tank
38A	½"	Copp.	" " " " Impermeator
38B	1 "	"	" " " " Emer. Bilge Pump Ejector
39	4½"	W I. & No. 11 Copp	Exh. From Gen. Sets
40	7½"	W. I.	" " " "
41	9 "	C. I.	" " " "
42	9 "	W.I. & No.10Copp.	" " " " to Cond. Direct
43	9 "	W. I.	" " " " to Exh. Main
44	4 "	"	" " Aft. Refr. to Exh. Main
45	7 "	W.I. & No.10 Copp.	Exh. Main
46	7 "	No 10 Copp.	" from Aux. to Main Cond.
46A	7 "	W. I.	" " " " Aux. "
47	7 "	W.I. & No.10 Copp.	" " " " L. P. Casing
48	7 "	W. I.	" " " " Heater
49	5½"	W.I. & No.11 Copp.	Vapour from Evap. to Cond.
50	5½"	W. I.	" " " " Exh. Main
51	4 "	No. 12 Copp.	" " "
52	4½"	W.I. & No.11 Copp.	Exh. from Circulating Pump (P. & S.)
53	1¼"	No. 13 Copp.	" " Turning Eng. (P. & S.)
54	2¼"	W.I. & No.13 Copp.	" " Air Pump (P. & S.)
55	1¼"	No. 13 Copp.	" " Rev. Eng. (P. & S.)
56	2 "	W. I.	" " Bilge Pump
57	2¾"	"	" " Bilge & San. Pumps
58	3¼"	"	" " " " & Ballast Pumps
59	8 "	"	Steam from L. P. Casing to Heater (P.&S.)
60	1 "	No. 14 Copp.	Exh. from Fresh Water Pump
61	1¾"	W. I.	" " Fresh Water & Aux. Feed Pump
62	3¾"	"	" " Fr. Wa. & Aux. Fd. Pp. 1 Mn. F.
63	3 "	"	" " Stb. Main Feed Pump
64	4½"	"	" " Aux. For. E. of E. R. to Exh. M.
65	5 "	No. 11 Copp.	" " St. Eng. & Capstan to Cond.
66	5 "	W. I.	" " " " " " " Exh. Main
67	6 "		" " Aux. to Atmosphere
68	½"	Copp.	" " Oil Pump to Exh. Main
69	1¾"		" " Hyd. Eng. Air & Cir. Pump
45A	6 "	W. I.	" " Aux. P. S. Aft. End of Eng. Rm.
69A	1¾"	W. I.	" " Hyd. Eng. A. & C. Pp. to Exh.M
70	22 "	C.I. & No. 5 Copp.	Circ. Pump Suct. (P. & S.)
71	22 "	C.I. & No. 5 Copp.	" " Disch. to Cond. (P. & S.)
72	22 "	C.I. & No. 5 Copp.	" " " Ovbd. (P. & S.)
73	9 "	W. I. & C. I.	" " Cross Conn. Betw. Cond.
74	7½"	W. I.	Aur Pump Disch. to Float Tank (P.& S.)
75	8½"	W. I. & C. I.	Wet Air Pump Suct. from Cond.
76	6¼"	W.I. & No. 9 Copp	" " " " Cross Conn.
77	5½"	"	Dry Air Pump Suct. from Cond. (P. & S.)
78	4 "	W.I. & No. 10 Copp	" " " " Cross Conn.

Pc. No.	Size	Material	Remarks
79	1½"	W. I.	Circ. Wa. for Air Pmp. Cool. Pipes (Inlet)
80	1½"	"	" " " from " " " (Outlet)..
81	6 "	No. 8 Copp.	Bilge Pump Suct. from Main Bilge
82	5 "	No. 9 Copp.	" " " " Ballast Tanks
83	4 "	C.I. & No. 10 Copp	" " " " Separate Bilge For.
84	4 "	No. 10 Copp.	" " " " " " " Aft.
85	6 "	No. 8 Copp.	San. and Ballast Pump Suct. from Sea
86	6 "	"	" Pump Suct. from Sea
87	6 "	"	" " " " Main Bilge
88	6 "	"	Ballast Pump Suct. from Sea
89	6 "	"	" " " " Main Bilge
90	5 "	No. 9 Copp.	" " " " Aft. Ballast Tanks
91			" " " " Cond. W/ways
92	5 "	No. 9 Copp.	" " " " Ford. Ballast Tanks
93	4 "	No. 10 Copp.	" " " " Separate Bilge
94	5 "	Lead	Flooding Pipe for Ford. Ballast Tanks
95	5 "	"	" " " " Aft. " "
96	4½"	No. 9 Copp.	Main Feed Pump Suct. from Ballast Main
97	4½"	S. D. Steel	" " " " " Boilers
98	7 "	W. I.	" " " " " Float Tank
99	7½"	"	" " " " " Heater
100	3½"	No. 10 Copp.	Aux. Feed Pump Suct. from Bilge
101	3½"	"	" " " " " Float Tank
102			" " " " " Cond.W/way
103	3½"	W. I.	" " " " " Sea
104	3 "	"	" " " " " F. W. Tanks
105	2 "	"	" " " " " No. 1 TankFW
106	1 "	"	Conn. from No. 1 Tank to Port Cond.
107	1 "	No. 14 Copp.	Sup. Feed to Main Cond.
108	1 "	W. I.	" " " Stb. Cond. from Bal. Main
109			Hot Water Supply from Mn. & Aux. Cond.
110	3½"	W. I.	Drain from Aux. Cond. to Fl. Tk. or A. Pp.
111	3½"	"	" " " " " Air Pump
112	2 "	No. 12 Copp.	Soda Water Conn...to Main Cond.
113	2 "	W.I. & No.12 Copp.	" " " From Float Tank
114	1 "	No. 14 Copp.	" " " " Bucket
118	6 "	Gal. W. I.	Bilge Pump Disch. Ovbd.
119	6 "	W. I.	San. Pump Separate Disch. to Deck
120	6 "	"	Ballast Pump Separate Disch. to Deck
121	5 "	"	Ballast & San. Pump Disch. to Aux. Cond.
122	6 "	Gal. W. I.	" " " " " Ovbd.
123	6 "	W.I. & No. 8 Copp.	Ballast Pump Disch. to Main Cond.
124		" "	" " " " to Hot Water Main
125	6 "	S. D. Steel	Main Feed Pump Disch. Thru Fil. to Heat.
126	4 "	W. I.	" " " " Ovbd.
127	5½"	S. D. Steel	" " " " to Aux. Feed
128	6 "	"	" " " " to Main Feed
129	4¾"	"	" " " " to Aux. Feed (Port)
130	¾"	"	Conn. from Aux. Feed for Fil. Launch Blr.
131	3 "	W. I.	Aux. Feed Pump Disch. Ovbd.
132	3 "	SDS & No. 6 Copp.	" " " " Thru Fil. to Aux. Feed
133		W. I.	" " " " to Hot Water Main
134			" " " " to F. W. Main
135	5 "	No. 9 Copp.	Aux. Cond. Disch. Ovbd.
136	6 "	W. I.	Heater Overflow to Overflow Tank
137	3 "	"	Drain from Overflow Tank to Float Tank
138	2½"	"	Water Service from Rising Main
139	4 "	"	" " " Supply from Sea
140	2¼"	"	" " " Disch. Ovbd.
141	2 "	No. 13 Copp.	Evap. Feed from Hot Water Main
142	2 "	"	" " " " Rising Mains
143	2 "	W. I.	" " (Combined)
144	1¾"	"	" " to Each Evap.
145	2½"	"	" Blow Down
146	1½"	"	" Branch to Sea
147	5¾"	"	" Safety Valve Overflow
148	6 "	C. I.	Bilge Injection
149	6 "	C. I. & Lead	Main Bilge
150	4 "	"	Separate Bilge Ford.
151	4 "	"	" " " Aft.
152	5 "	"	Ballast Main Ford.
153	5 "	"	" " " Aft.
154	3 "		Hot Water Main
155	4½"	W. I.	Hyd. Air Pump Disch. to Float Tank
156	4½"	No. 8 Copp.	" " & Cir. Pump Suct. from Sea
157	4½"	W. I.	" " " " " " Disch. Ovbd.
158	3½"	"	Aft. Refr. Suct. from Sea
159	3½"	W.I. & No.10Copp.	" " Disch. Ovbd.
160	1¼"	W. I.	" " Feed Disch. to Float Tank
161	2¾"	"	" " Aux. Water Sup. from Bal. Pmp
162	1¾"	"	Drain from Ford. Refrig. to Float Tank
163	4 "	"	Air Pipe from Float Tank

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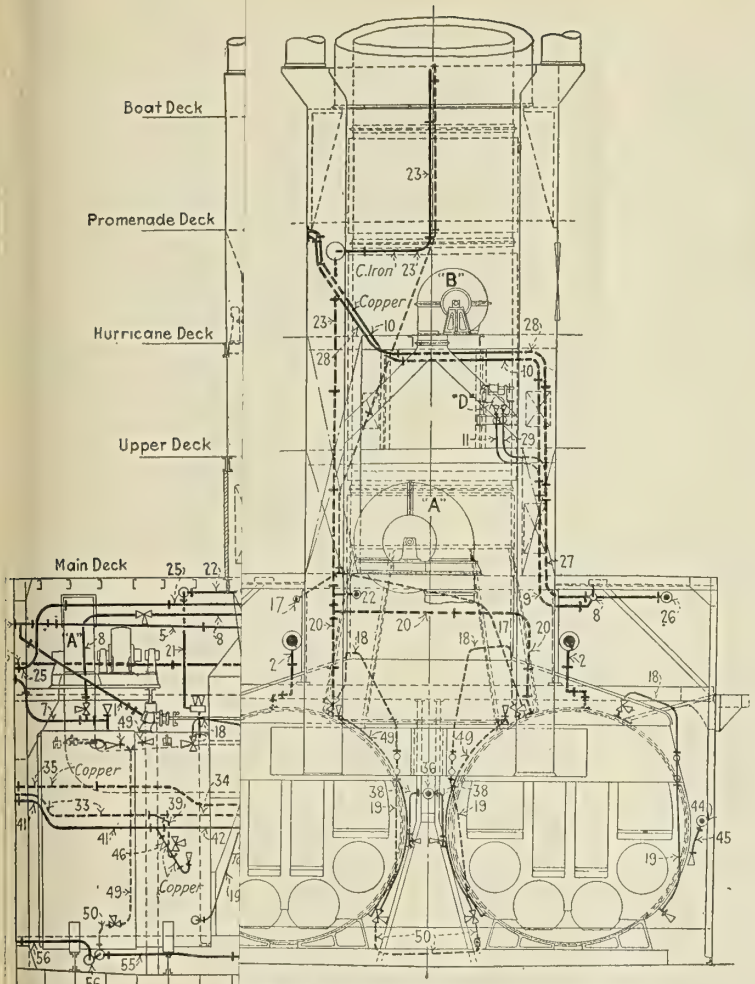
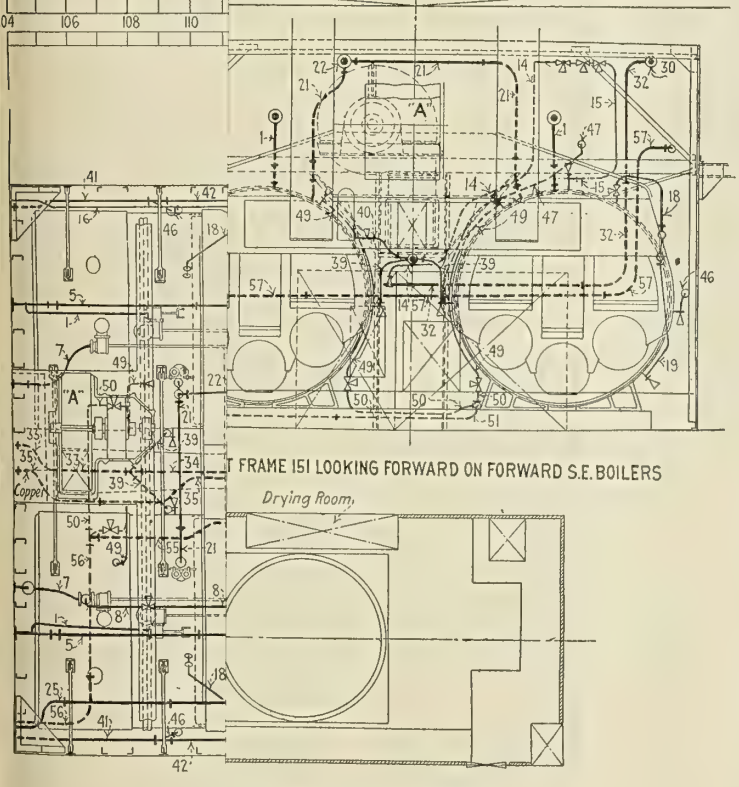


T FRAME 137 LOOKING FORWARD ON FORWARD D.E. BOILERS



T FRAME 151 LOOKING FORWARD ON FORWARD S.E. BOILERS

MAIN DECK-FORWARD STOKEHOLD

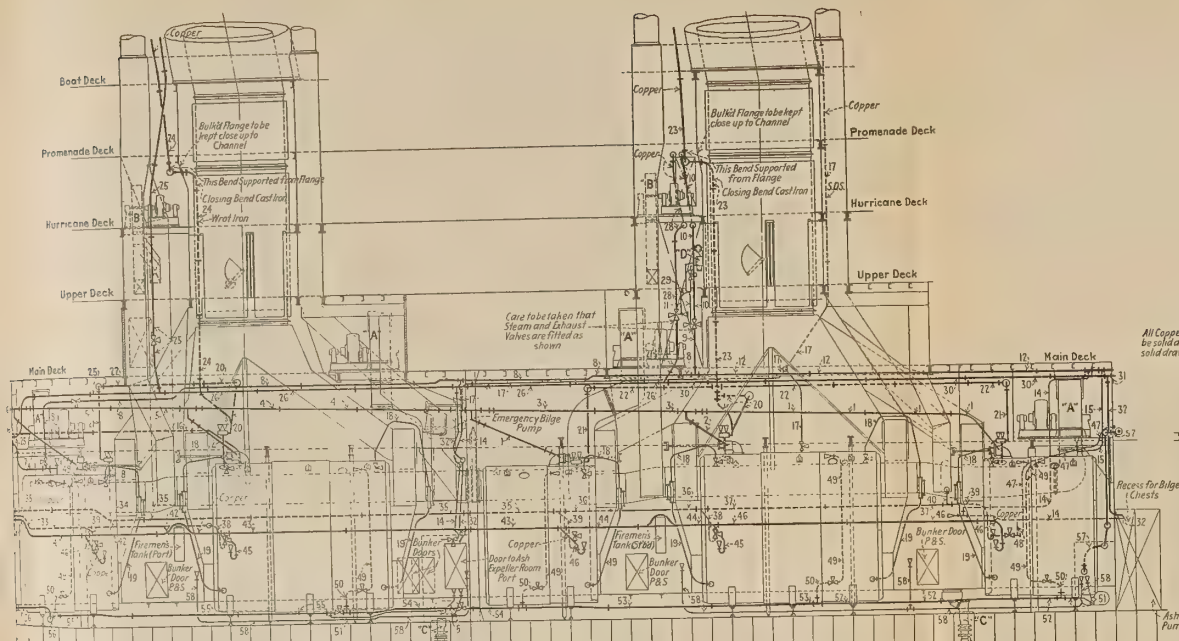
LIST OF BOILER ROOM PIPES

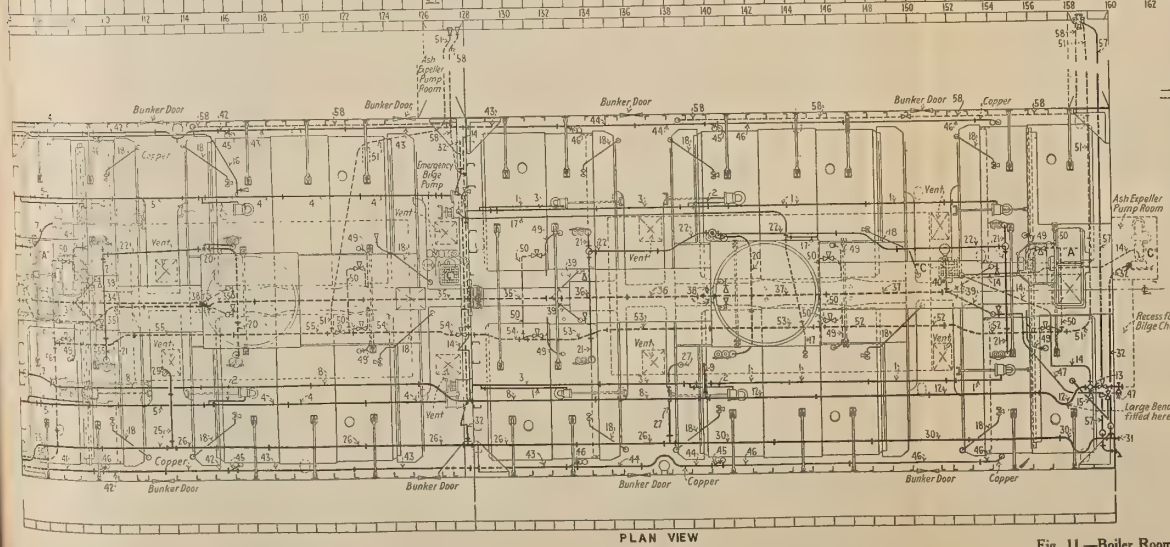
Pc. No.	Dia.	Thickness	Material	Remarks
1	6″	9/32″	W. Iron	Main Steam from S. E. Boilers
2	8″	11/32″	"	" " " D. E. "
3	9″	13/32″	"	" " " " For'd S. E. & D. E. Boilers
4	10″	7/16″	"	" " " " " B. R.
5	12″	1/2″	"	" " " " For'd B. R. & Aft. D. E. Boilers
6	13″		G. I. Y Piece	" " Combined
7	6″	1 W.G.	Copper	Aux. Steam to Eng. Room
8	4″	1/4″	S. D. S.	" " " Deck & For'd Refr.
9	4″	1/4″	S. D. S.	" " " " & Ash Hoist
10	4″	5 W.G.	Copper	
		1/4″	S. D. S.	" " " "
11	1″	W.G. 10	Copper	" " " Ash Hoist
12	3½″	3/16″	S. D. S.	" " " For'd Refr. & Ash Expeller
13	3¼″			" " " " Refr.
14	2″	3/16″	S. D. S.	" " " Ash Expellers
14A				" " " Bunkers (Fire Exting. Conn.)
15	3¼″	3/16″	S. D. S.	Steam to For'd Refr. from For'dS.E.Boiler (Stb.)
16	3¼″	3/16″	S. D. S.	" " Steering Engine
17	2″	8 W.G.	Copper	" " Whistle
		3/16	S. D. S.	
18	1½″	W.G. 6	Copper	" " Gage Glass
19	1¼″	6	"	Water " "
20	6½″	1/4″	W. Iron	Waste Steam from D. E. Boilers
21	4¾″	W.G 5	"	" " " " S. E. "
22	6¾″	1/4″	"	" " " " S. E. " Comb.
23	13¼″	W. G. 10	Copper	" " Up Funnel For'd B. R.
23	13¼″	1/4″	W. Iron	" " " " " "
24	11½″	W. G. 11	Copper	" " " " Aft. "
24	11½″	1/4″	W. Iron	" " " " " "
25	6″	1/4″	"	Aux. Exhaust to Atmosphere
25	6″	W.G. 12	Copper	" " " "
26	5″	1/4″	W. Iron	Exh. from Deck & For'd Refr.
27	5″	1/4″	"	" " " " Ash Hoist
28	5″	11 W.G	Copper	" " Deck
		1/4″	W. Iron	
29	1¼″	W.G. 13	Copper	" " Ash Hoist
30	5″	1/4″	W. Iron	" " For'd Refr. & Ash Expeller
31	4½″			" " " "
32	4″	W.G. 6	W. Iron	Exh. from Ash Expeller
33	4¾″	1/4″	S. D. S.	Main Feed to Aft. B. R.
34	4¼″	1/4″	S. D. S.	" " " " " D. E. Boilers (Comb.)
35	5½″	1/4″	S. D. S.	" " " For'd "
35	5½″	W.G. 1	Copper	" " " " "
36	4¾″	1/4″	S. D. S.	" " " " " D.E. & S.E. Boil. (Com.)
37	3½″	3/16″	"	" " " " " For'd S.E. Boil. (Comb.)
38	3″	W.G. 6	Copper	" " " D. E. Boilers in For'd and Aft. B. R.
39	2½″	W.G. 7	"	" " " " S. E. Boilers in For'd and Aft. B. R.
40	2″	W.G. 8	"	" " Conn. to Air Vessel in For'd B. R.
41	4¾″	1/4″	S. D. S.	Aux. Feed Combined
42	4½″	1/4″	S. D. S.	" " to Aft. D. E. Boilers & For'd B. R.
42	4½″	W.G. 3	Copper	" " " " " " " " " "
43	3¾″	3/16″	S. D. S.	" " " For'd B. R.
44	3¼″	3/16″	S. D. S.	" " " " D.E. & For'd S.E. Blrs. (Com.)
44	3¼″	W.G. 5	Copper	" " " " " " " " " "
45	3″	W.G. 6	"	" " " " D. E. Boilers in For'd & Aft. B.R.
46	2½″	W.G. 7	"	" " " " S. E. " " " " " " "
46	2½″	3/16″	S. D. S.	" " " " " " " " " " "
47	1¾″	3/16″	S. D. S.	For'd Refr. Feed Pump Disch. to Boiler & Float Tank.
48	1¾″	W.G. 6	W. Iron	For'd Refr. Feed Pump Disch. to Float Tank
49	1″	W.G. 8	Copper	Surface Blow Off
50	2″	3/16″	S. D. S.	Bottom Blow Off & Boiler Circ.
51	2″	3/16″	S. D. S.	" " " to Ship Side
52	2¾″	3/16″	"	Boiler Circ. For'd S. E. Boilers
53	3¼″	3/16″	"	" " " S. E. & D. E. Boilers
54	3½″	3/16″	"	" " from For'd B. R. (Comb.)
55	4″	3/16″	"	Boiler Circ. from For'd B.R. & Aft. D. E. Boiler
56	4½″	3/16″	"	Boiler Circ. Comb. to Feed Pump
57	4½″	W.G. 5	W. Iron	For'd Refr. Sea Suct.
58	1¼″	W.G. 7	"	Firemen's Water Service
59				Fire Conn. (Steam to Bunkers)
60				Conn. for Washing Out Boilers
61				Ballast Main
62				Bilge Main
63				Separate Bilge

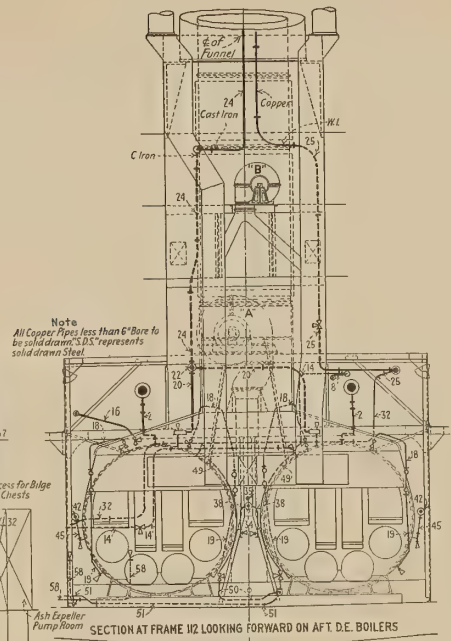
BOILER ROOM AUXILIARIES

Mark	Purpose
A	Forced Draft Fan
B	Ventilating Fan
C	Ash Expeller
D	Ash Hoist

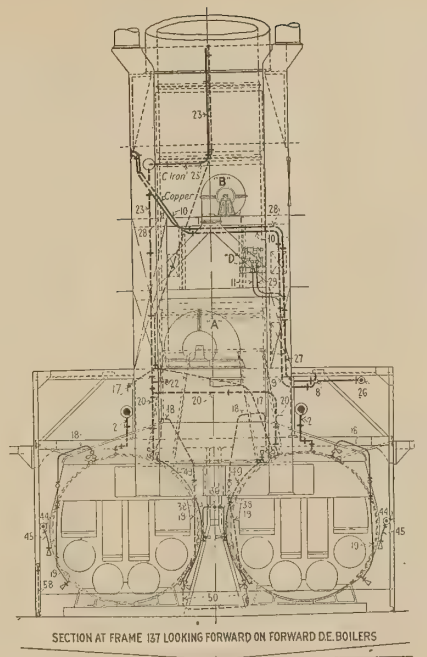
PASSENGER AND MAIL STEAMSHIP NALDERA







SECTION AT FRAME 112 LOOKING FORWARD ON AFT D.E. BOILERS



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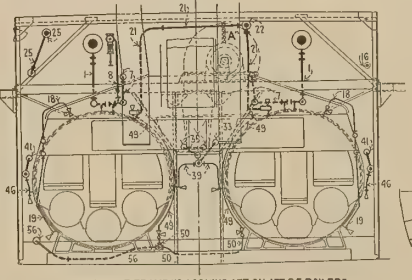
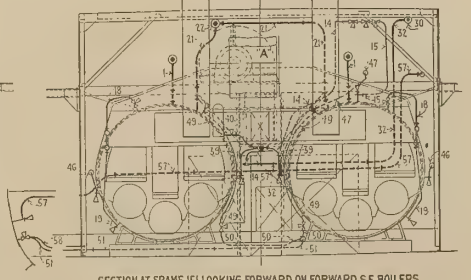
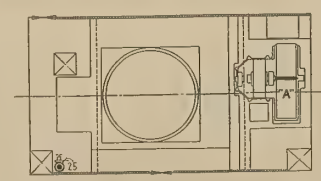


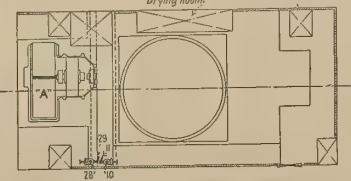
SECTION AT FRAME 112 LOOKING AFT ON AFT S.E. BOILERS



SECTION AT FRAME 151 LOOKING FORWARD ON FORWARD S.E. BOILERS



PLAN AT MAIN DECK-AFT STOKEHOLD



PLAN AT MAIN DECK-FORWARD STOKEHOLD

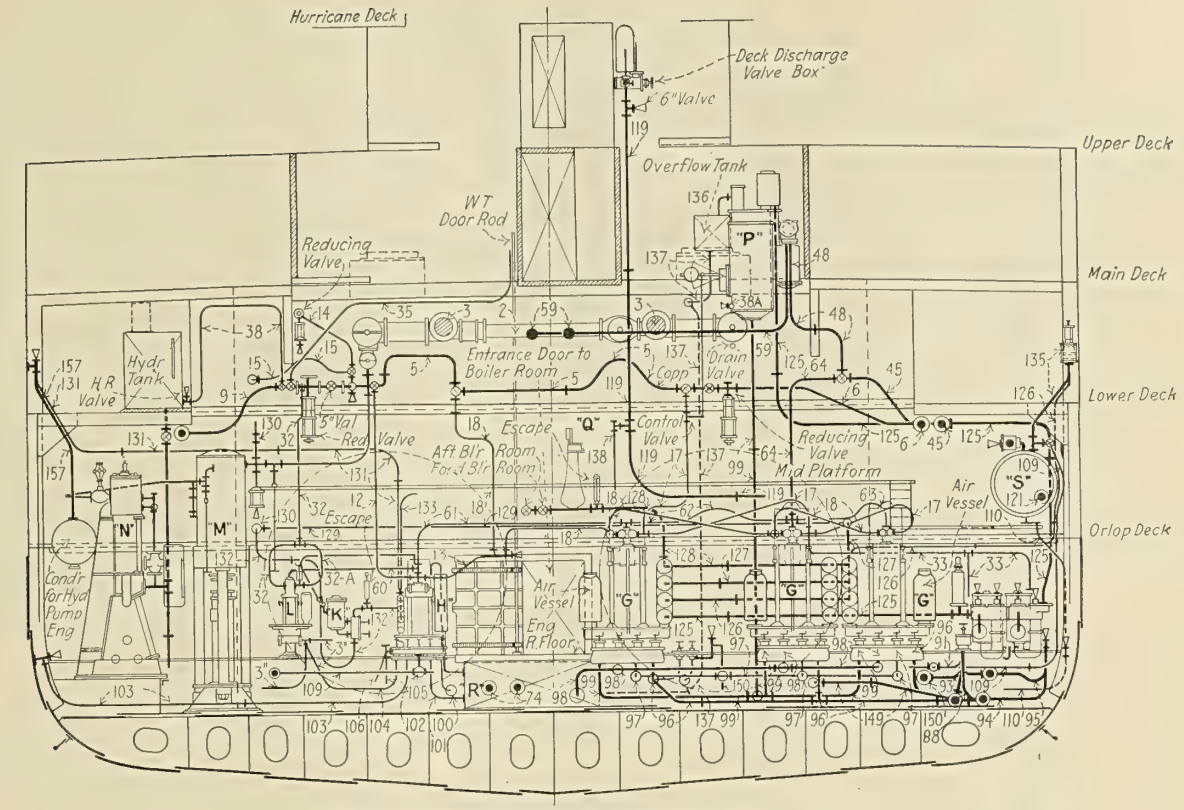
Fig. 11.—Boiler Room Piping and Arrangement Plans

LIST OF BOILER ROOM PIPES

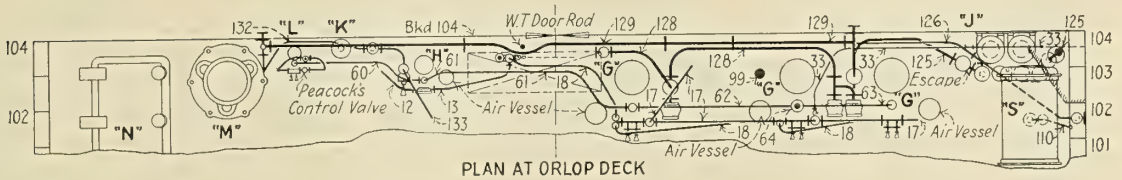
Po. No.	Dia.	Thickness	Material	Remarks
1	6″	9/32″	W. Iron	Main Steam from S. E. Boilers
2	8″	11/32″	"	" " " D. E. "
3	9″	13/32″	"	" " " For'd S. E. & D. E. Boilers
4	10″	7/16″	"	" " " B. R.
5	12″	1/2″	"	" " " For'd B. R. & Aft. D. E. Boilers
6	13″		G. I. Y Piece	" " Combined
7	6″	1 W.G.	Copper	Aux. Steam to Eng. Room
8	4″	1/4″	S. D. S.	" " " Deck & For'd Refr.
9	4″	1/4″	S. D. S.	" " " " & Ash Hoist
10	4″	5 W.G.	Copper	" " " "
		1/4″	S. D. S.	
11	1″	W.G.	Copper	" " " Ash Hoist
		10		
12	3 3/4″	7/16″	S. D. S.	" " " For'd Refr. & Ash Expeller
13	3 1/4″			" " " " Refr.
14	2″	5/16″	S. D. S.	" " " Ash Expellers
14A				" " " Bunkers (Fire Exting. Conn.)
15	3 1/4″	3/16″	S. D. S.	Steam to For'd Refr. from For'd S.E. Boiler (Stb.)
16	3 1/2″	1/4″	S. D. S.	" " Steering Engine
17	2″	8 W.G.	Copper	" " Whistle
		5/16	S. D. S.	
18	1 1/2″	W.G.	Copper	" " Gage Glass
		6		
19	1 1/2″	6	"	Water " "
20	6 1/2″	1/4″	W. Iron	Waste Steam from D. E. Boilers
21	4 1/2″	W.G	"	" " " S. E. "
		5		
22	8 1/2″	1/4″	"	" " " S. E. " Comb.
23	13 1/2″	W.G.	Copper	" " Up Funnel For'd B. R.
		10		
23	13 1/2″	1/4″	W. Iron	" " " " "
24	11 1/2″	W.G.	Copper	" " " " Aft. "
		11		
24	11 1/2″	1/4″	W. Iron	" " " " "
25	6″	1/4″	"	Aux. Exhaust to Atmosphere
26	6″	W.G.	Copper	" " " " "
		12		
26	5″	1/4″	W. Iron	Exh. from Deck & For'd Refr.
27	5″	1/4″	"	" " " " Ash Hoist
28	5″	11 W.G.	Copper	" " Deck
		1/4″	W. Iron	
29	1 3/4″	W.G.	Copper	" " Ash Hoist
		13		
30	5″	1/4″	W. Iron	" " For'd Refr. & Ash Expeller
31	4 3/4″			" " " "
32	4″	W.G.	W. Iron	Exh. from Ash Expeller
		5		
33	4 1/4″	1/4″	S. D. S.	Main Feed to Aft. B. R.
34	4 1/2″	1/4″	S. D. S.	" " " D. E. Boilers (Comb.)
35	5 1/2″	1/4″	S. D. S.	" " " For'd "
35	5 1/2″	W.G.	Copper	" " " " "
		1		
36	4 1/4″	1/4″	S. D. S.	" " " " D.E. & S.E. Boil. (Com.)
37	3 3/8″	1/4″	"	" " " " For'd S.E. Boil. (Comb.)
38	3″	W.G.	Copper	" " " D. E. Boilers in For'd and Aft. B. R.
39	2 1/4″	W.G.	"	" " " S. E. Boilers in For'd and Aft. B. R.
		7		
40	2″	W.G.	"	" " Conn. to Air Vessel in For'd B. R.
		8		
41	4 1/4″	1/4″	S. D. S.	Aux. Feed Combined
42	4 1/2″	1/4″	S. D. S.	" " to Aft. D. E. Boilers & For'd B. R.
42	4 1/2″	W.G.	Copper	" " " " " " " "
		3		
43	3 1/4″	1/4″	S. D. S.	" " " For'd B. R.
44	3 1/4″	1/4″	S. D. S.	" " " D.E. & For'd S.E. Blrs. (Com.)
44	3 1/4″	W.G.	Copper	" " " " " " " " "
		5		
45	3″	W.G.	"	" " " D. E. Boilers in For'd & Aft. B.R.
		6		
46	2 1/2″	W.G.	"	" " " S. E. " " " " " "
		7		
46	2 1/2″	1/4″	S. D. S.	" " " " " " " " " "
47	1 3/4″	1/8″	S. D. S.	For'd Refr. Feed Pump Disch. to Boiler & Float Tank.
48	1 3/4″	W.G.	W. Iron	For'd Refr. Feed Pump Disch. to Float Tank
		6		
40	1″	W.G.	Copper	Surface Blow Off
		8		
50	2″	1/4″	S. D. S.	Bottom Blow Off & Boiler Circ.
51	2″	1/4″	S. D. S.	" " " " to Ship Side
52	2 1/4″	1/8″	"	Boiler Circ. For'd S. E. Boilers
53	3 1/4″	1/8″	"	" " " S. E. & D. E. Boilers
54	3 1/4″	1/8″	"	" " " from For'd B. R. (Comb.)
55	4″	1/8″	"	Boiler Circ. from For'd B.R. & Aft. D. E. Boiler
56	4 1/2″	1/8″	"	Boiler Circ. Comb. to Feed Pump
57	4 1/2″	W.G.	W. Iron	For'd Refr. Sea Suct.
		9		
58	1 1/4″	W.G.	"	Firemen's Water Service
		7		
59				Fire Conn. (Steam to Bunkers)
60				Conn. for Washing Out Boilers
61				Ballast Main
62				Bilge Main
63				Separate Bilge

BOILER ROOM AUXILIARIES

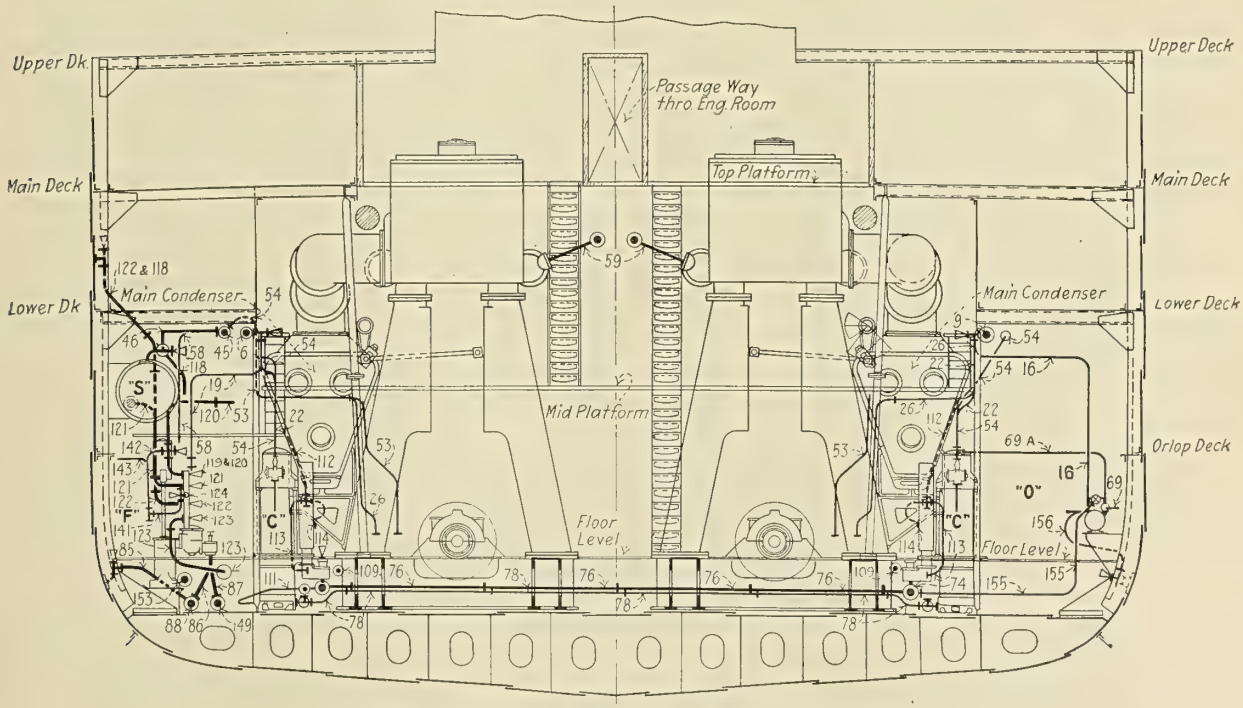
Mark	Purpose
A	Forced Draft Fan
B	Ventilating Fan
C	Ash Expeller
D	Ash Hoist



VIEW LOOKING FORWARD ON BKD. 104



PLAN AT ORLOP DECK



SECTION AT FRAME Nº 98 LOOKING AFT

Fig. 10.—Sections Through Engine Room, S. S. *Naldera*

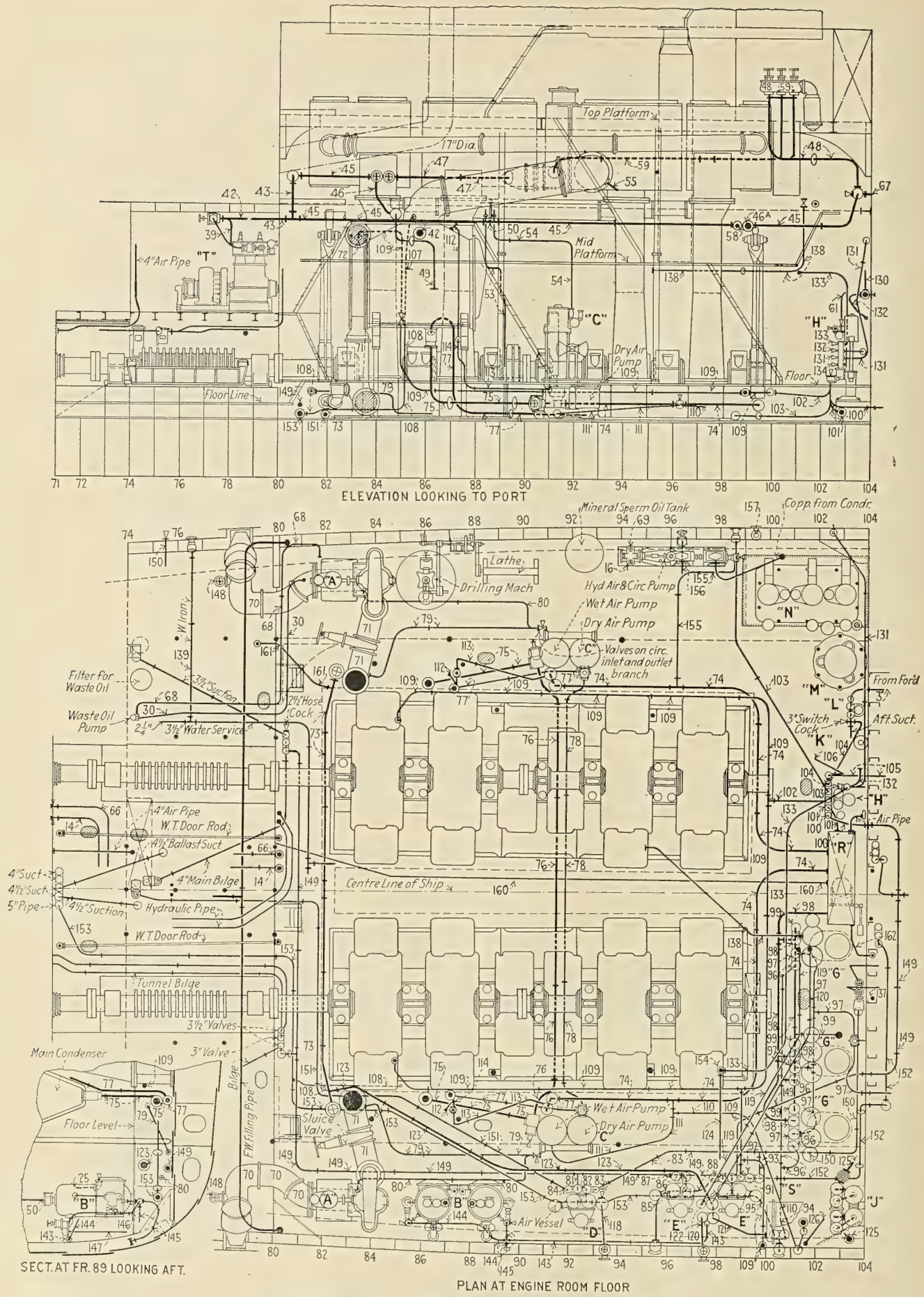


Fig. 11.—Machinery and Piping Arrangement, S. S. *Naldera*

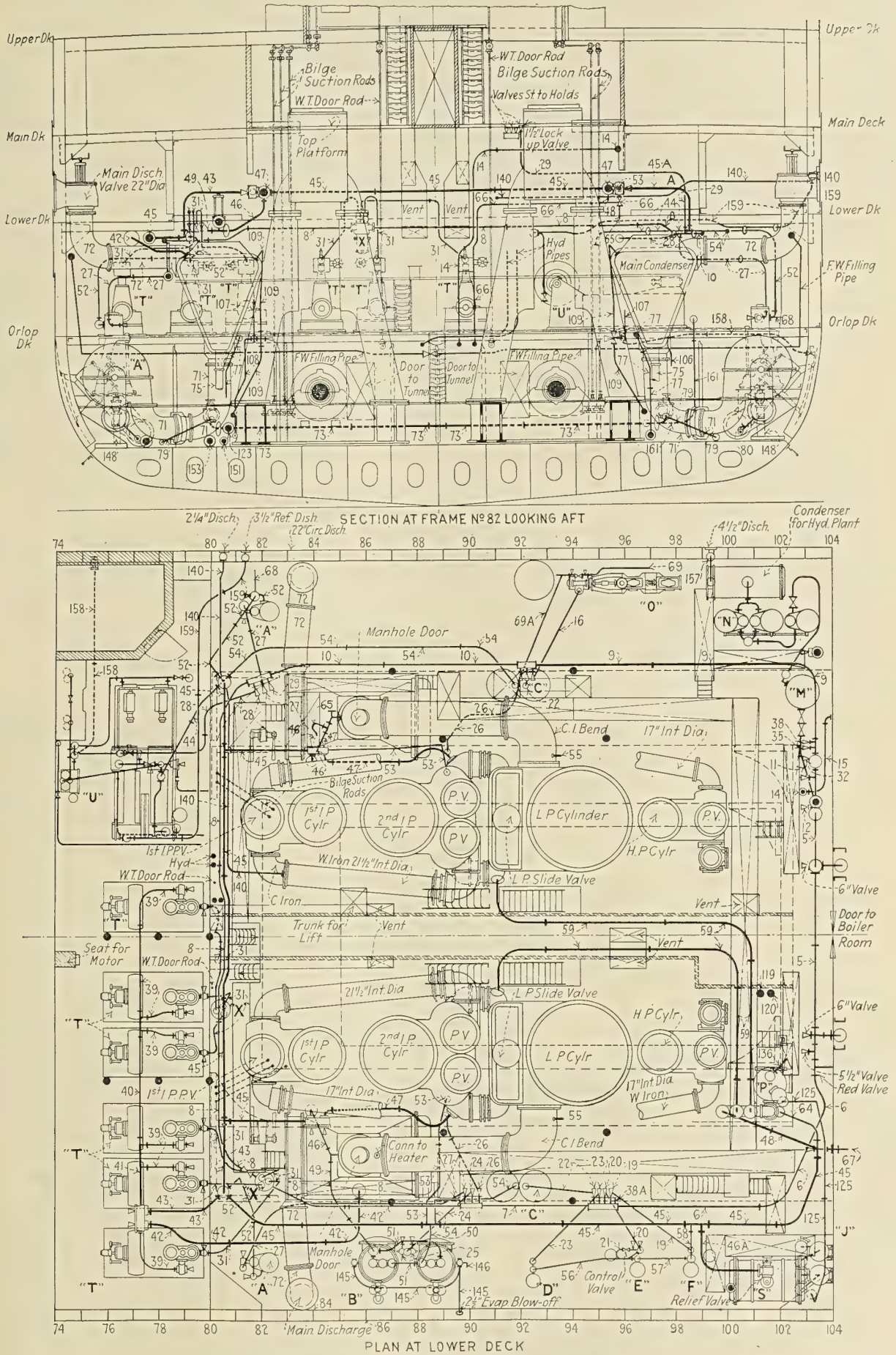


Fig. 12.—Machinery and Piping Arrangement

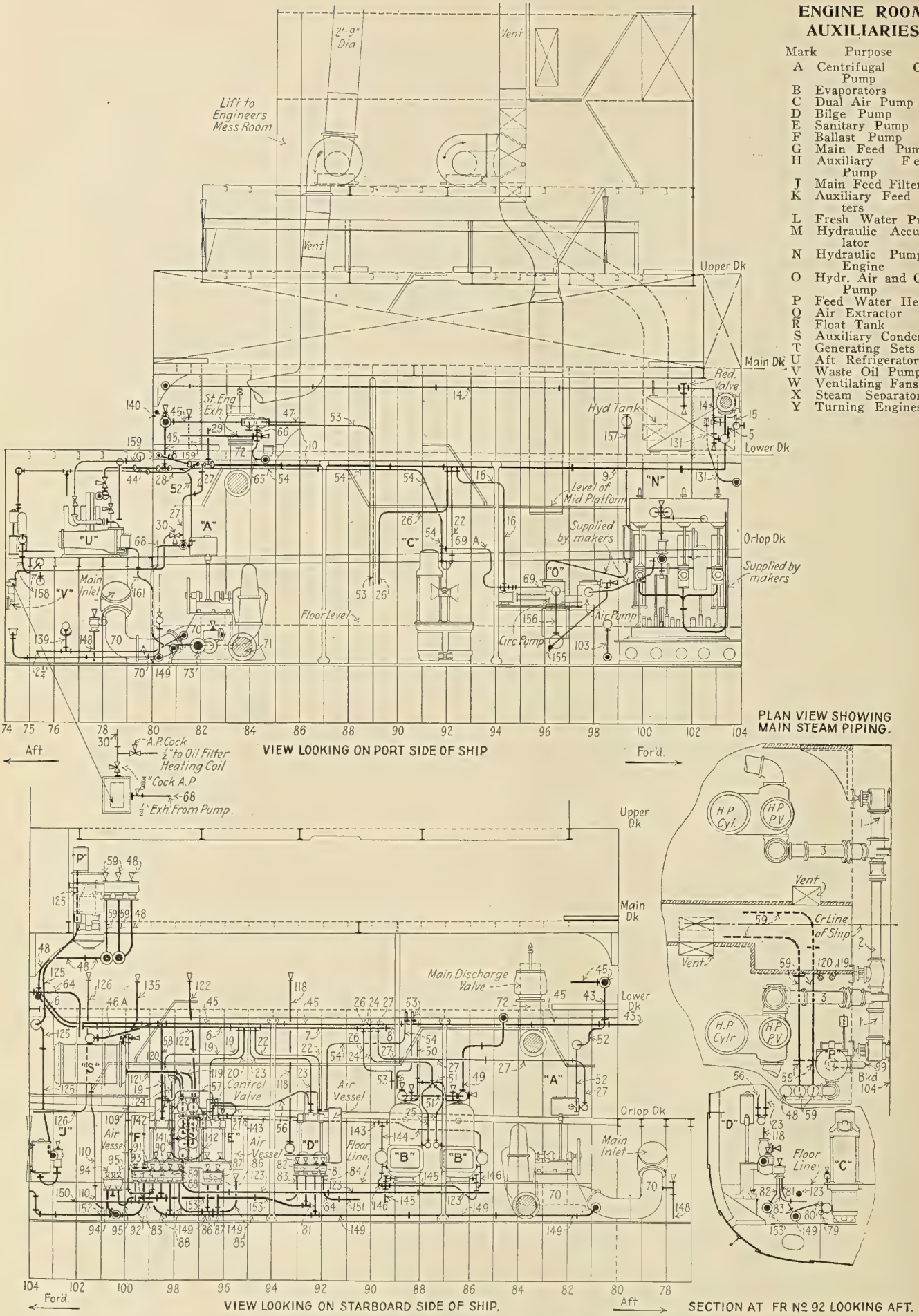


Fig. 13.—Outboard Longitudinal Sections of Engine Room, S. S. *Naldera*

Normal Manning Requirements of United States Shipping Board Vessels

Single Screw Average Speed Coal and Oil Burning Cargo Ships.

DECK DEPARTMENT

Rank		Coal Burning Vessels									Oil Burning Vessels								
	D.W.T. I.H.P.	3000 1000	4000 1250	5000 1500	6000 1750	7000 2000	8000 2250	9000 2500	10000 2750	11000 3000	3000 1000	4000 1250	5000 1500	6000 1750	7000 2000	8000 2250	9000 2500	10000 2750	11000 3000
Master		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Chief Officer		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2nd Officer		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3rd Officer		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carpenter		—	—	—	1	1	1	1	1	1	—	—	—	1	1	1	1	1	1
Bosun		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	—
Quartermaster		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
A. B. Seaman		6	6	6	7	7	7	8	8	8	6	6	6	7	7	7	8	8	8
Ordinary Seaman		2	2	2	3	3	3	4	4	4	2	2	2	3	3	3	4	4	4
Total		13	13	13	16	16	16	18	18	18	13	13	13	16	16	16	18	18	18

Note: All wooden steamers to carry carpenters.

ENGINE DEPARTMENT

Chief Engineer	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1st Asst	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2nd Asst	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3rd Asst	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Deck Engineer	—	—	—	1	1	1	1	1	1	—	—	—	—	1	1	1	1	3	3
Water Tender	—	—	—	—	—	—	—	3	3	—	—	—	—	—	—	—	—	1	1
Store Keepers	—	—	—	—	—	1	1	1	1	—	—	—	—	—	—	—	—	3	3
Oilers	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Firemen	3	6	6	6	6	9	9	9	9	3	3	3	3	3	3	3	3	—	—
Coal Passers	3	3	3	3	3	6	6	6	6	—	—	—	—	—	—	—	—	—	—
Wipers	—	—	—	—	—	—	—	—	—	2	2	2	2	2	3	3	3	3	3
Total	13	16	16	17	17	24	24	27	27	12	12	12	13	13	14	14	18	18	

Note: All vessels with two or more W. T. Boilers to carry three water tenders. Fire room crew to be regulated by position of boilers. Forced or natural draft, number of fires and arrangement of bunkers.

Total Personnel Deck and Engine Depts.	26	29	29	33	33	40	42	45	45	25	25	25	29	29	30	32	36	36	

STEWARD'S DEPARTMENT.

Personnel based on deck and engine complement.

Chief Steward	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Chief Cook	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2nd Cook and Baker	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Utilityman	—	—	—	1	1	1	1	1	1	—	—	—	—	—	—	1	1	1	1
Messmen	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Messboys	1	1	1	1	1	2	2	2	2	1	1	1	1	1	1	1	1	1	1
Total	6	6	6	7	7	8	8	8	8	6	6	6	6	6	6	7	7	7	
Total Crew	32	35	35	40	40	48	50	53	53	31	31	31	35	35	36	39	43	43	

Should vessel require more men in Steward's Department on account of arrangement—before adding to crew, matter to be taken up with United States Shipping Board's Port Steward.

Cable Steamer All America

Twin-Screw Cable Laying and Repairing Vessel Under Construction in England for the All America Cables, Inc.

THE cable steamer *All America,* a duplicate of the steamer *Guardian* owned by the Central & South America Telegraph Company, is now under construction at the Neptune Works of Swan, Hunter & Wigham Richardson, Ltd., Walker-on-Tyne, England, for the All America Cables, Inc., New York.

The *All America* is a twin screw cable laying and repairing steamer, built under Lloyd's special survey to class 100 A-1 and arranged to conform to the requirements of the American Bureau of Shipping.

Her characteristics are as follows:

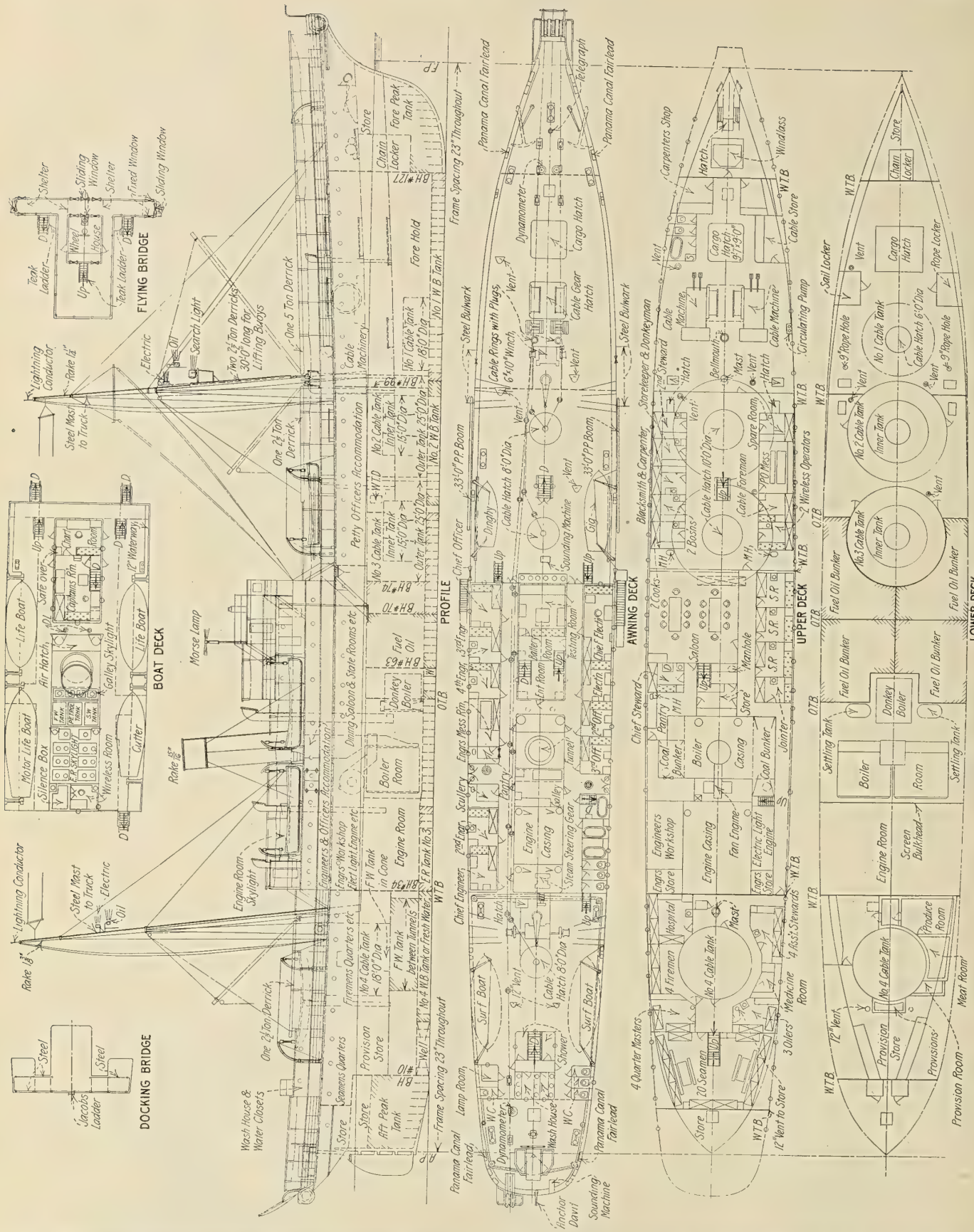
Length overall	295 feet 0 inches
Length between perpendiculars	270 feet 0 inches
Beam, molded	37 feet 0 inches
Depth, molded, to awning deck	24 feet 9 inches
Speed, knots	11
Designed mean draft	18 feet 0 inches
Deadweight capacity at 18-foot draft	1,750 tons
Maximum draft, summer freeboard	20 feet 0 inches

The vessel has four cable tanks, three forward and one aft. All these tanks have steel cones and the two largest tanks have inner tanks. The total coiling capacity of the cable tanks is about 14,000 cubic feet. The cable machinery, which is being supplied by the Telegraph Construction & Maintenance Company, of London, is of their latest and most improved pattern. There are three bow sheaves forward and one aft, and the necessary deck leads, dynamometers, telegraphs, etc.

A large testing room and battery room are provided on the awning deck, and there are also workshops and suitable arrangements for storing the buoys and special appliances used in cable repairing work.

The accommodation for the telegraph and cable staff is very complete. The accommodation for the captain, ship's officers and engineers and crew is also of a superior type.

The propelling machinery consists of two triple expansion engines with cylinders having diameters of 15½ inches, 25 inches and 43 inches by 30 inches stroke. Steam is supplied



General Arrangement Plans of the Cable Laying and Repairing Steamer *All America*

by two oil burning Scotch boilers, 13 feet 3 inches diameter by 11 feet 6 inches long, at 180 pounds pressure. The boilers are fitted with Howden's system of forced draft. A donkey boiler is fitted for auxiliary steam. The bunkers have a capacity of about 500 tons of fuel oil.

The auxiliary machinery includes one steam driven and one oil driven electric light and power generating set, refrigerating machinery, Lucas sounding machine, two steam winches, steam windlass, steam steering gear and a radio set having a day range of 200 miles.

The vessel's equipment includes a motor lifeboat, two steel lifeboats and working boats suitable for the vessel's service.

The *All America* will begin her career under the command of Captain Taylor, who for several years commanded the *Guardian* and has had considerable experience in cable laying and repair work.

Fig. 1.—*Clemson* Type Destroyer at Full Speed

Successful Performance of Recent Destroyers

Vessels of the Clemson Class, Driven by Westinghouse Cross-Compound Geared Turbines, Give Excellent Results on Official Trials

AT the outbreak of the war the United States had about forty serviceable destroyers in commission, but as the vital importance of these vessels was immediately established, this country began building them in large numbers, so that when the armistice was signed there were about 350 of this type in service and under construction.

There was also a marked increase in their dimensions. The typical destroyers of 1914 had a length of about 300 feet, a beam of 26 feet, a displacement of 900 tons, a speed of 30 knots and a horsepower of around 15,000. These vessels rendered an excellent account of themselves on both sides of the Atlantic during the war, but the need for greater seaworthiness and higher speed was plainly seen. Every new class authorized, therefore, had greater size and speed, until the last class, authorized in October, 1917, was given a length of 310 feet, a beam of 31 feet, a full load displacement of 1,308 tons, a speed of 35 knots and a horsepower of 28,000.

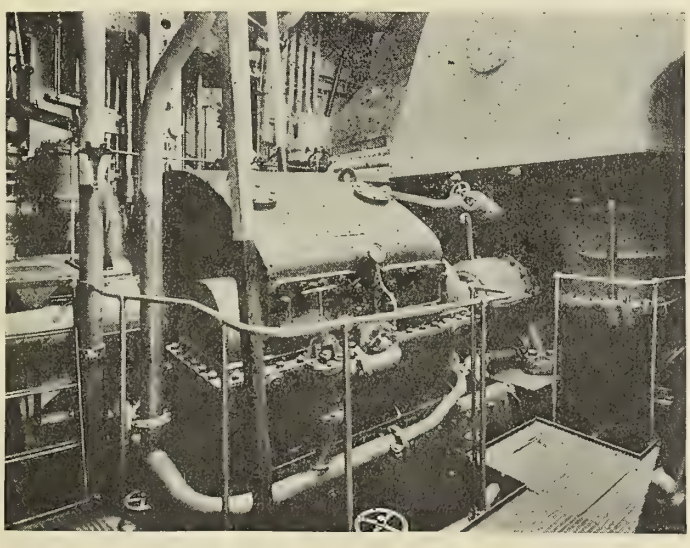


Fig. 2.—Gears and Turbines

Twenty-seven of this last class, known as the *Clemson* class, are now completed, fourteen having been built by the Newport News Ship Building & Dry Dock Company and thirteen by the New York Ship Building Corporation, with seven more to come from the latter builder.

The motive power of each of these vessels consists of two Westinghouse cross-compound geared turbines

Fig. 3.—Destroyers Under Construction at Yard of New York Shipbuilding Corporation, Camden, N. J.

rated at 14,000 horsepower each. This machinery has been so carefully designed to occupy the limited room available that it, together with all auxiliaries, takes up only 1,550 square feet of space and represents probably the maximum concentration of power to be found in any engine room.

Each turbine consists of a high pressure and a low pressure element, which drive a propeller through a common floating frame reduction gear. Either element can be used independently so that the ship is not completely crippled if even three of the four elements are out of commission. An astern turbine is incorporated in each low pressure element, and a cruising turbine, to give economical speeds of 15 knots or less, in each high pressure element.

The first of this class to go on trial was the *Clemson*. On her first trip her gears were found to be too noisy, but this was readily corrected, and on the official trials of all of the

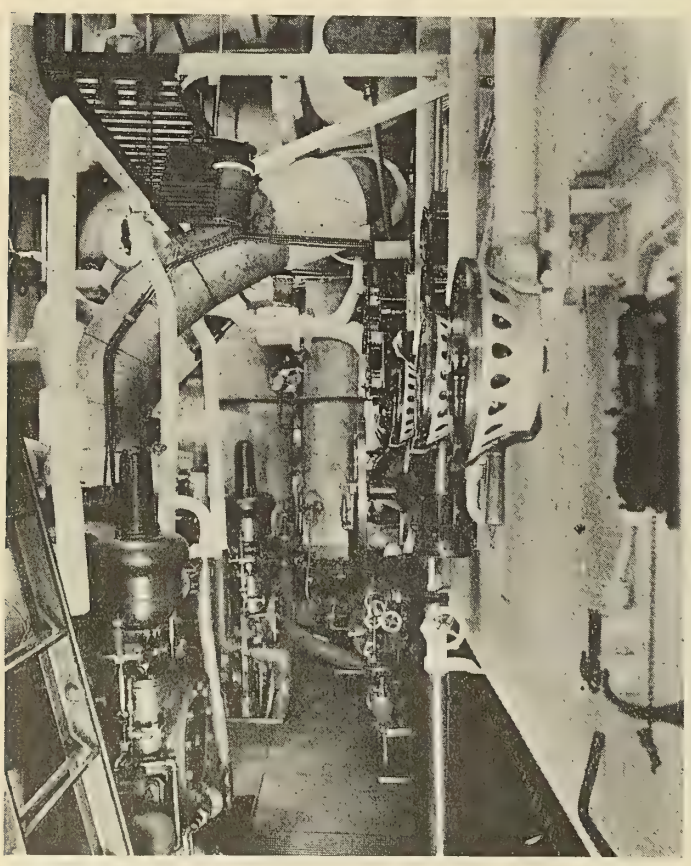


Fig. 4.—Control Platform

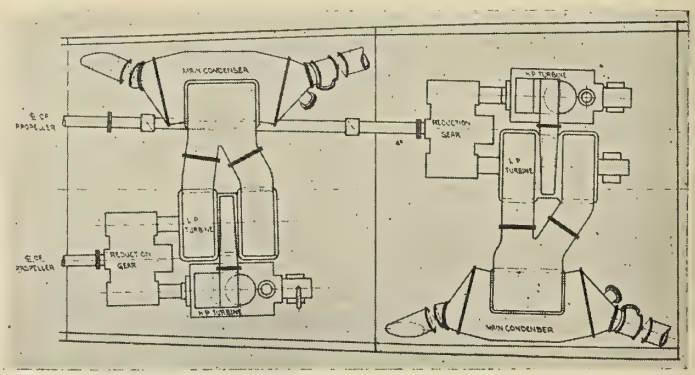


Fig. 5.—Machinery Arrangement of *Clemson* Type Destroyer

succeeding twenty-six boats the operation of the machinery proved to be so satisfactory that none has had to be repeated.

The fifth boat delivered by the Newport News yard, the *Satterlee,* was taken to Rockland, Me., for official standardization trials. She distinguished herself by making an average of 37.17 knots on her five high speed runs, at 486 revolutions per minute and 1,230 tons displacement, with a maximum speed of 38.26 knots, which constitutes the fastest official run ever made by a vessel of the United States Navy. She also broke another record by developing 31,223 shaft horsepower with her turbines. Later reports from the *Satterlee* state that "she is not afraid of any other ship running away from her."

The second vessel from the yards of the New York Shipbuilding Corporation, the *Brooks,* was likewise thoroughly tested at Rockland and showed excellent speeds and fuel economies.

Passenger and Cargo Steamship Hawkeye State

(*Continued from page* 194.)

lubrication are provided with ample oil supply and discharge channels with nozzles at the main turbine bearing pedestals and reduction gear frames. The supply nozzles are fitted with pressure gages and the discharge nozzles have sight flow indicators and thermometers.

The turbine glands are sealed with the steam leakoff from the inlet head high pressure turbine gland. This sealing steam pressure is controlled by valves at each of the sealed glands and by valve connection to both the low pressure turbine chest and exhaust. If this leakoff proves insufficient, steam is admitted to the sealing line from the auxiliary exhaust. All turbine glands and casings are drained through valves to the low pressure exhaust casing from where the water is removed by a vacuum trap.

Boilers

There are eight watertube boilers of the Yarrow type, built by the Bethlehem Shipbuilding Corporation, Ltd., at their Fore River Plant, Quincy, Mass., while the mechanical fuel oil burners were manufactured at the Redington Plant. These boilers have a total heating surface of 40,000 square feet and are built for a working pressure of 265 pounds per square inch. Foster superheaters will give 75 degrees superheat at nominal full power.

The boilers work under forced draft, using the closed stokehold system. Airlocks are provided between the two firerooms, between the after fireroom and engine room and to the escape trunks, which extend to the upper deck. Vertical sliding watertight doors are located in the first two of the above airlocks, and operate from the upper deck.

Trials

The sea trials were conducted on January 17, over a measured mile off the Delaware Breakwater. The ship was at a mean draft of 24 feet and displaced about 16,070 tons.

The tabulated result of the three trials follows, the water rate of the turbines being referred to a uniform standard of 250 pounds pressure per square inch at the turbines, 75 degrees superheat and 28-inch vacuum:

	One-Half Power	Three-Quarters Power	Full Power
Duration of trial, hours	6	6	12
Revolutions per minute	102	111	125
Speed in knots	15.5	16.8	18.8
Shaft horsepower	7,110	9,930	13,000
Water rate of turbines, pounds	11.40	10.64	9.98
Boiler pressure, pounds per square inch	260	260	261
Pressure at high pressure turbine chests	247	244	238
Pressure at low pressure turbine chests	2.1	1.1	5.6
Vacuum, inches	29.13	28.8	28.64

There was an entire absence of noise and vibration at all speeds, and outside of the engine room it was impossible to tell whether or not the engines were running. Such a performance promises well for the comfort of the passengers and speaks well for the builders of hull and machinery.

It is believed that the speed obtained makes this the fastest ocean steamship built since the war, and the 13,200 shaft horsepower obtained makes this the most powerful geared turbine outfit yet installed on a commercial vessel in the United States. It is also believed that the model is one of the best, if not the most efficient in the passenger service.

A feature of particular interest in connection with the *Hawkeye State* and her sister ships building at Sparrow's Point is, that, although the ship was not built entirely at one plant, it was, to an unusual degree, the product of one corporation. All of the five eastern plants of the Bethlehem Shipbuilding Corporation, Ltd., contributed certain manufactured parts in which the particular plant specialized. This, indeed, is the "Bethlehem" practice on all contracts.

On this ship, parts were contributed by other plants than Sparrow's Point somewhat as follows:

The Fore River Plant at Quincy, Mass., made the turbines, boilers, and ventilator cowls.

The winches, windlass, gypsies, steering engine and telemotor fittings are of the regular Bethlehem-Moore design and manufacture, being made at the Moore Plant, Elizabeth, N. J., which plant also furnished a large part of the iron castings.

The Harlan Plant at Wilmington, Del., furnished the boats, hinged watertight doors, portable stateroom furniture and tables and buffets in main dining saloon.

The Redington Plant at Redington, Pa., made the rectangular airports in the public rooms on the bridge and boat decks, and the fuel oil burners.

In addition to all structural work and built-in joiner work, the Sparrow's Point Plant made most of the forgings and a large part of the brass castings.

The Bethlehem Steel Company contributed structural material, drop forgings and iron and steel castings from several of its plants.

It is, therefore, evident that, to an unusual degree, full advantage has been taken of the vast and varied "Bethlehem" resources in producing a ship which might be justly termed the last word in American shipbuilding practice.

To Compute Cargo Space

THE United States Bureau of Standards has worked out, for the use of shippers, the following formula for computing the hold space required for a shipment of barrels, when the internal contents in cubic feet are known:

$$V = \frac{2.81}{2 - \frac{1}{L} - \frac{1}{W}} \times v \times N,$$

where

V = total hold space required.
v = internal contents in cubic feet.
1 gallon = 0.134 cubic feet
L = number of barrels in length of bottom layer.
W = number of barrels in width of bottom layer.
N = number of barrels in shipment.

The coefficient

$$\frac{2.81}{2 - \frac{1}{L} - \frac{1}{W}}$$

varies with the shape and size of hold. For existing commercial conditions the range of variation of the coefficient is in all probability between 1.5 and 1.8.

Assume a shipment of 134 fifty-gallon barrels, the bottom layer 10 barrels long and 4 barrels wide; then

L = 10.
W = 4.
v = 50 × 0.134 cubic feet.
= 6.7 cubic feet.
N = 134 barrels.

Substituting in the formula

$$V = \frac{2.81}{2 - \frac{1}{10} - \frac{1}{4}} \times 6.7 \times 134$$

= 1.7 × 6.7 × 134.
= 1,526 cubic feet of hold space required.

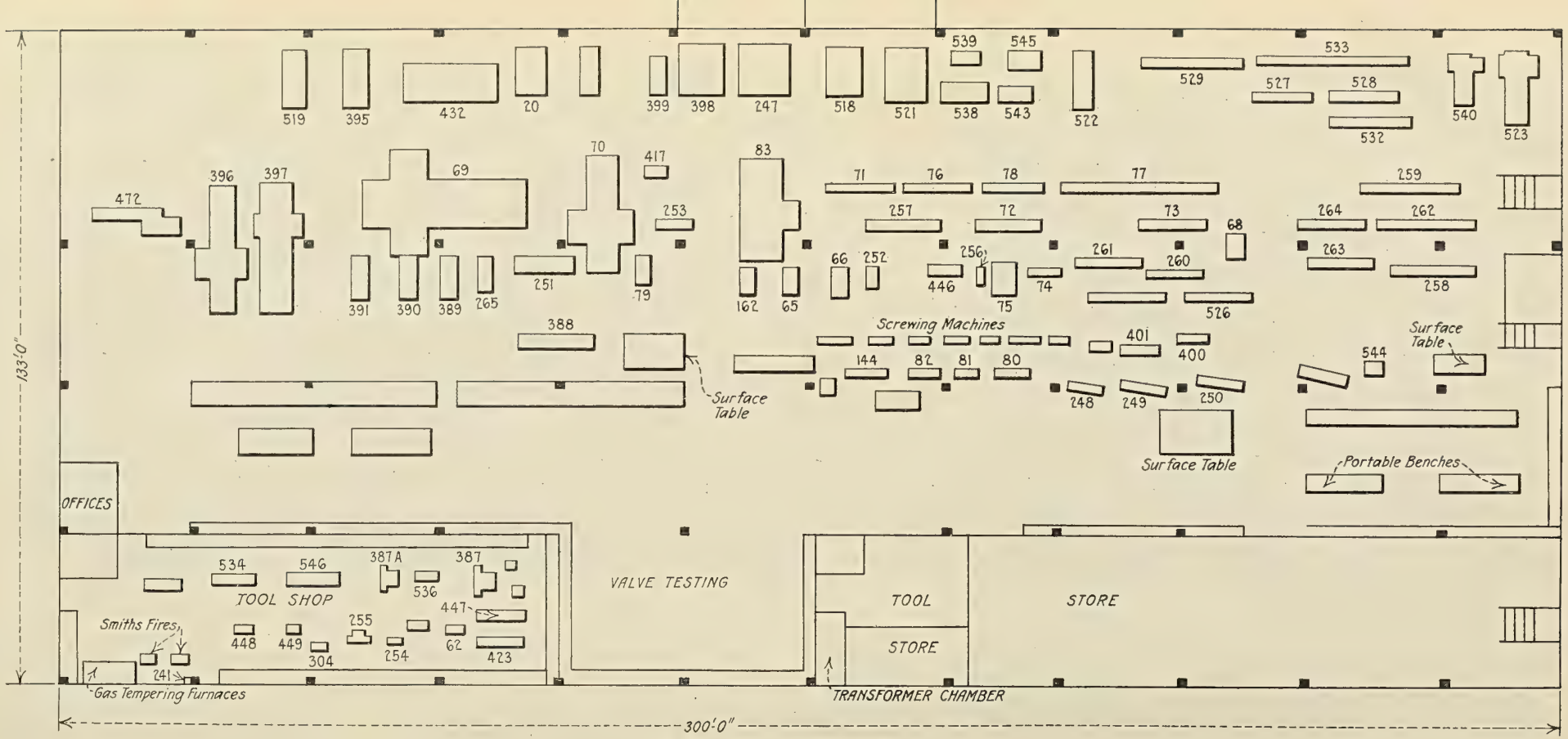


Fig. 17.—Layout of Fitting Shop

Fitting Shop

MACHINES

Key No. Description and Size

20 Bandsaw and 6½ H. P. motor.
62 Cincinnati milling mach.
65 Radial drill, 42″.
66 Radial drill, 42″.
67 Capstan lathe.
68 Milling mach.
69 Motor-driven planer, 7′ x 5′-6″ x 14′.
70 Planer, 4′ x 3′-6″ x 10′.
71 Lathe, 8″ x 12′-6″ bed.
72 Center lathe, 10½″.
73 Center lathe, 10½″.
74 Surfacing and boring lathe, 30″.
75 Shaping mach., 26″ stroke.
76 Four-jaw chuck lathe, 8″.
77 Lathe, 10″ x 30′-6″ bed.
78 Four-jaw chuck lathe, 10″ x 12′-6″ bed.
79 Patent slotting mach., 12″ stroke.
80 Bolt screwing mach.
81 Double bolt cutter, 1¼″.
82 Double bolt cutter, 1¼″.
83 Worm-driven horiz. boring and facing mach.
107 Patent screwing mach.
144 Nut tapping mach.
162 Grindstone.
241 Centrifugal fan.
247 Horiz. drilling and tapping mach.
248 Hexagonal turret lathe.
249 Capstan lathe.
250 Capstan lathe.
251 Radial drilling mach., 5′-6″.
252 Single spindle drilling machine.
253 Radial drill, 4′-2″.
254 Twist drill grinding mach.
255 Univ. grinding mach.
256 Key seating mach.
257 Center lathe, 10½″.
258 Center lathe, 8½″.
259 Center lathe, 8½″.
260 Center lathe, 6½″.
261 Center lathe, 6½″.
262 Center lathe, 10½″.
263 Center lathe, 8½″.
264 Center lathe, 8½″.
265 Slotting mach., 12″.
274 2 smiths' fires.
275 Surface plate, 6′-0″ x 4′-0″.
304 Wet tool grinder, 12″.
375 Port. milling mach.
384 Screwing mach.
385 Screwing mach.
386 Cincinnati vert. milling mach.
387 Cincinnati univ. milling mach.
387A Cincinnati univ. milling mach.
388 Radial drilling, boring and studding mach., 6′-0″ radius.
389 Radial drilling, boring, tapping and studding mach., 4′-6″ rad.
390 Radial drilling, boring, tapping and studding mach., 4′-6″ rad.
391 Radial drilling, boring, tapping and studding mach., 4′-6″ rad.
392 Radial drilling, boring, tapping and studding mach., 4′-6″ rad.
393 Radial drilling, boring, tapping and studding mach., 4′-6″ rad.
394 Patent slotting mach., 12″ stroke.
395 Slotting mach., 24″ stroke.
396 Planning mach., to place 4′-0″ x 42″ high; 10′-0″ long.
397 Planing mach., to plane 4′-0″ x 42″ high; 10′-0″ long.
398 Boring and facing mach.
399 Band sawing mach.
400 Capstan lathe.
401 Capstan lathe.
417 Pipe flange facing mach.
423 Hollow spindle lathe, 7″.
429 Twin-chambered furnace with blower.
432 Surfacing and boring mach.
433 Gun ring mach.
445 Radial drill, 5′-0″.
446 Radial drill, 5′-0″
447 Lathe, 7″.
448 Sensitive drill.
449 Drill grinder.
450 Univ. grinder.
472 Surfacing and boring mach.
518 Boring and tapping mach.
519 Slotting mach.
520 Lathe.
521 Boring and facing mach.
522 Radial drill, 6′-0″.
523 Planing mach., 10′-0″.
526 Lathe, 10″.
527 Lathe, 10″.
528 Lathe, 10″.
529 Lathe, 13″.
530 Lathe, 10″.
531 Lathe, 8″.
532 Lathe, 8″.
533 Lathe, 12″.
534 Lathe, 8″.
535 Turret lathe.
536 Lathe, 7″.
538 Slotter, 13″.
539 Slotting mach., 7″.
540 Planer, 6′-2″ x 2′-5″.
541 Radial drill, 5′-0″.
542 Radial drill, 3′-0″.
543 Radial drill, 5′-0″.
544 Sensitive drill.
545 Vert. drill.
546 Vert. milling mach.
562 Oscillating tool grinder.
563 Plain grinder.
601 Gun ring mach. (graduating).
606 Peter's abrasive cutting-off mach.

CRANES

84 10-ton crane (span 40′-9″); hoist, 10 tons 15 F. P. M.; cross travel, 100 F. P. M.; long travel, 300 F. P. M.
85 10-ton crane (span 25′-9″); hoist, 10 tons, 15 F. P. M.; cross travel, 75 F. P. M.; long travel, 300 F. P. M.

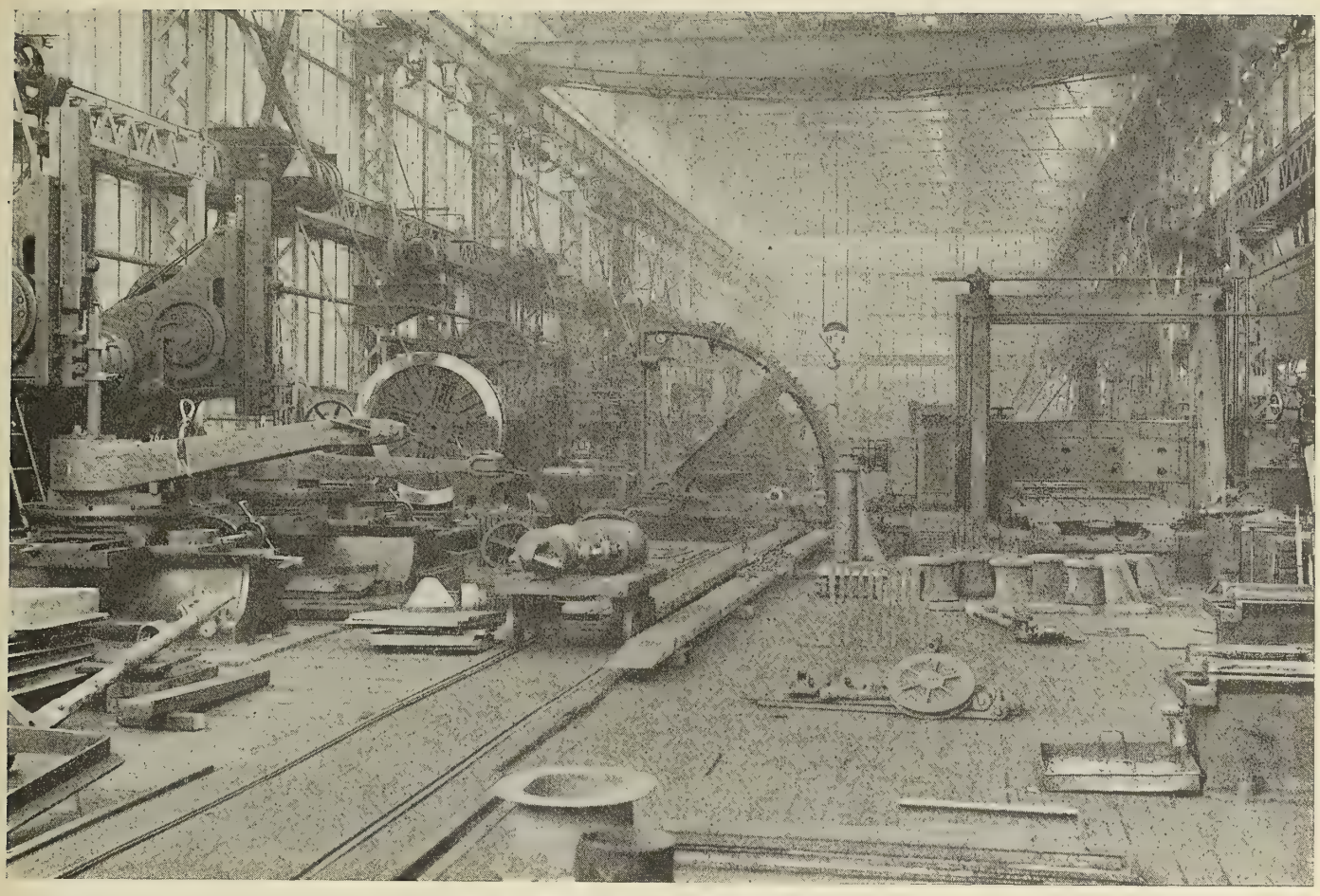


Fig. 18.—Fitting Shop—View of South Bay

One of England's Largest Shipyards—II

Continuation of Description of Plant of the Sir W. G. Armstrong, Whitworth and Company, Limited, at Newcastle-on-Tyne

IN the preceding issue of this magazine the general layout of plant and the structural shops of the Armstrong yard of the Sir W. G. Armstrong, Whitworth & Company, Limited, were described in considerable detail. The following is a continuation of the above and describes in detail the remaining shops which make up this prominent addition to the merchant shipbuilding resources of England.

Fitting Shop

The fitting shop is a steel framed structure similar in character to those already described. It is 300 feet long by 133 feet wide and is divided into four bays; that on the southern side has a clear width of 44 feet, while the two central bays are each 28 feet wide and the bay on the northern side is 29 feet wide. An upper floor extends over two of the bays along the northern side, providing accommodation for the sailmakers, model makers and riggers. The sail loft is equipped with power driven sewing machines for dealing with canvas work of all descriptions.

The fitting shop is particularly well equipped with heavy tools originally intended for warship work. Although these may not all be so fully employed now that the yard is engaged in merchant shipbuilding, it is a distinct advantage to have them available for use at any time. From Fig. 17 it will be noted that the tools are all arranged in the two bays on the south side of the shop and each is provided with a 10-ton electric overhead traveling crane.

Tool Equipment

The tool equipment includes a number of modern lathes, turret lathes, nut tapping machines and bolt screwing machines. There are also surface, boring and facing machines specially designed for boring "A" brackets for vessels of moderate size and some 42-inch sensitive radial drills which are largely employed for drilling and tapping holes for the ¼-inch screws used with metal strips for securing India rubber gaskets on watertight doors. There are a number of radial drills, shaping machines and slotting machines. Figs. 18 and 19 show views of the central and south bays of the fitting shop, and on the right in Fig. 18 is shown a planing machine which is the only tool in the shop calling for special comment.

This machine was specially designed for transverse as well as longitudinal planing and is a particularly convenient tool for working on watertight doors, etc. It can accommodate work up to 14 feet long by 7 feet wide by 5 feet 6 inches deep and is driven by electric equipment giving longitudinal cutting speeds ranging from 18 feet to 72 feet per minute, with a quick return of from 100 feet to 150 feet per minute. The transverse cutting speeds are two-thirds of the longitudinal speeds. The change over from longitudinal to transverse planing is effected by means of a mechanically operated clutch, the time taken for the operation being, of course, only a very small fraction of the time which would be occupied in resetting the work. Both the bed and table are specially de-

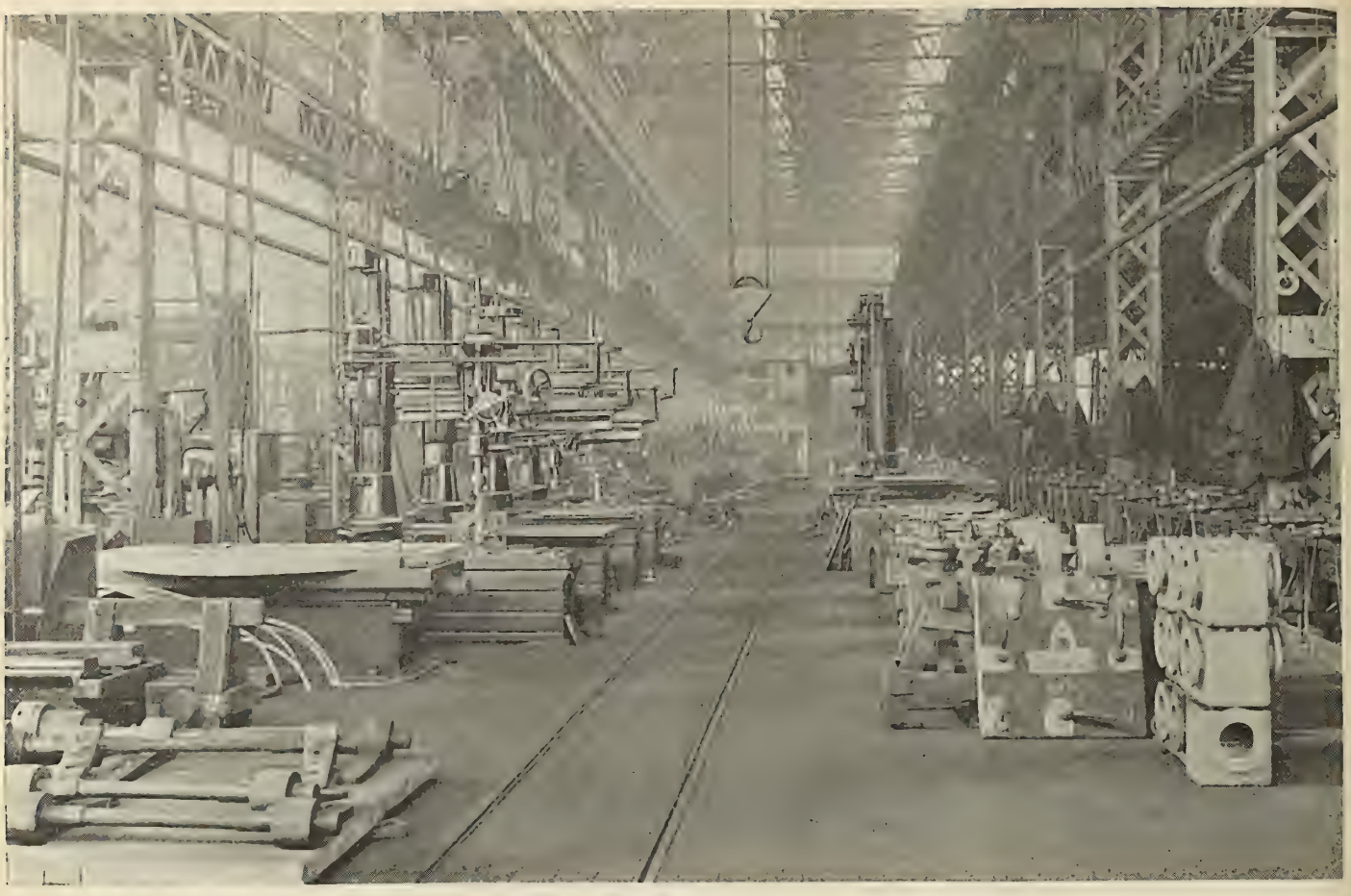


Fig. 19.—Fitting Shop—View of Center Bay

Fig. 20.—Blacksmith Shop

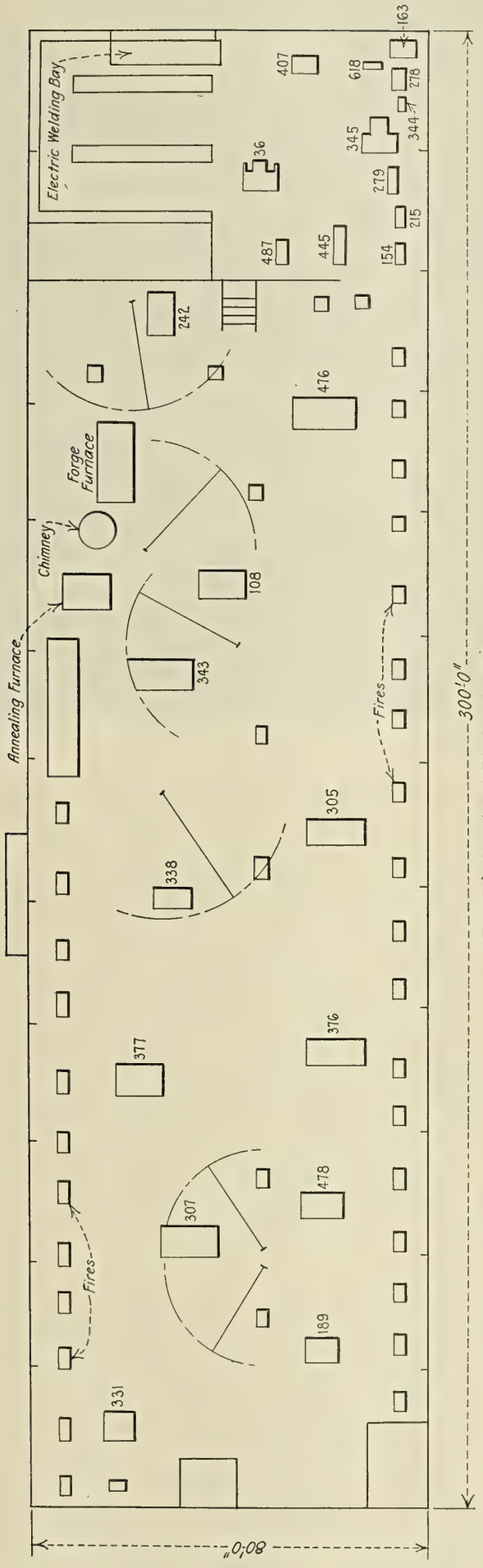


Fig. 21.—Layout of Blacksmiths' Shop

Blacksmith Shop

MACHINES

Key No.	Description and Size
86	Punch, shears and notcher.
108	Pneumatic hammer, 40 cwt.
123	Smiths' fires with four high pressure motor-driven fans (6½ horsepower motors).
189	Pneumatic hammer, 5 cwt.
154	Plain grinder.
163	Grindstone.
188	High pressure motor-driven fan (6½-horsepower motor).
215	Drill.
242	Pneumatic hammer, 42″ stroke; air inlet, 4″ diameter; 15 cwt.
278	Plain grinder.
279	Radial drill.
305	Pneumatic hammer, 10 cwt.
307	Pneumatic hammer, 3 cwt.
331	Pneumatic hammer, 3 cwt.
338	Pneumatic hammer, 15 cwt.
343	Pneumatic hammer, 20 cwt.
344	Single grinder.
345	Vertical drill.
376	Pneumatic hammer, 10 cwt.
377	Pneumatic hammer, 15 cwt.
407	Band saw.
445	Capstan lathe.
476	Pneumatic hammer, 10 cwt.
478	Pneumatic hammer, 7½ cwt.
487	Radial drill.
618	Swing frame grinder.

CRANES

166	Hand crane, 3-ton, 21′ radius.
167	Hand crane, 3-ton, 21′ radius.
168	Hand Crane, 3-ton, 25′ radius.

signed for the reception of heavy work and the machine is arranged so that all operations, including the starting and stopping of the table, are controlled from the front. Safety switches are provided on both sides to prevent the possibility of overrunning of the table.

Another machine of the same type, but rather smaller and arranged for belt driving, is also provided.

Most of the machines in the shop are belt driven from line shafting carried on roller bearings, but some of the larger tools are provided with independent electric motors.

Tool Shop, Stores and Testing Departments

About half of the bay on the northern side of the shop is partitioned off to form a tool store and a store for finished parts and a portion of the space is utilized for the hydraulic testing of castings for valves, etc. The remainder of this bay is occupied by the tool shop in which the whole of the small tools, gages, etc., required in the yard are made, adjusted and repaired. This tool shop is equipped with gas-fired hardening and tempering furnaces, twist drill grinder, a universal grinder and an oscillating grinder which is used for making lathe and planer tools by grinding from the bar without forging.

For cutting up bars of high speed steel for making tools, a 10-inch carborundum wheel 1/10 inch in thickness and running at 4,600 revolutions per minute is employed. This has been found to effect a considerable saving in time on this work.

A gear planer for miter and bevel wheels is also installed in the shop, as well as a number of engraving machines. One of these machines is specially arranged for marking degrees on steering dials and other angular work of this character.

A graduating machine, specially designed by Messrs. Armstrong for engraving gun rings, is also installed in this shop.

For checking the dimensions of gages and of finished work, a large vernier caliper is used. This instrument is fitted with agate-faced jaws which can be adjusted by means of fine screws and is capable of reading up to 60 inches by thousandths; a microscope is provided for reading the vernier.

Blacksmith Shop

The blacksmiths' shop, which is situated between the angle racks and the fitting shop, occupies the greater part of a building which has a total length of 300 feet and a width of 80 feet. The actual dimensions of the blacksmiths' shop are

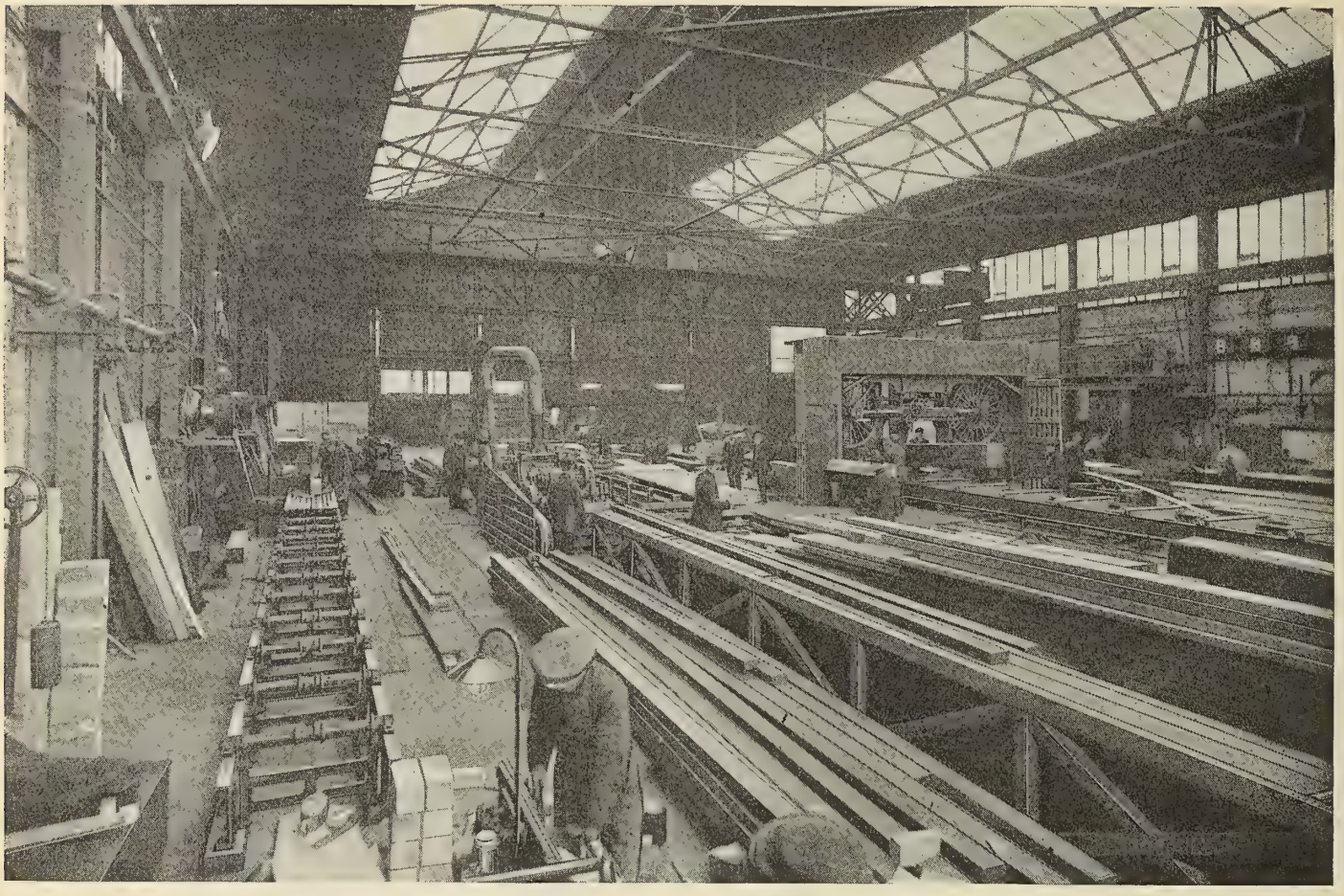


Fig. 22.—Saw Mill

250 feet long by 80 feet wide, the remaining portion of the building at the western end forming the blacksmiths' fitting shop.

Main Smiths' Shop

In the main smiths' shop, Figs. 20 and 21, fires are arranged along both sides of the building and a system of grouping similar to that described in connection with the anglesmiths' shop has been adopted.

The blast is supplied by four high pressure fans which deliver air at a pressure of 14 inches of water gage through galvanized steel pipes fitted with cast iron connections to the fires. The smoke from the fires is carried away by uptakes connected in convenient groups to funnels which are sufficiently high to provide a natural draft.

Practically the whole of the forgings and stampings required in the yard are produced in this shop, which is equipped with twelve power hammers. These range from 3 hundredweight to 2 tons in capacity, the smaller hammers being of the electro-pneumatic type, while the larger ones are worked by compressed air from the yard power station.

For heating heavy work a gas-fired regenerative furnace 6 feet 6 inches long by 4 feet wide is provided and there is also a smaller furnace for annealing the forgings. These furnaces, and also the larger hammers, are conveniently served by hand power cranes. Bogie rails are also laid to facilitate the handling of the work.

Blacksmiths' Fitting Shop

In the blacksmiths' fitting shop, above referred to, articles such as handrails, stanchions, ladders, gratings, etc., are made and the equipment includes a punching and shearing machine with notching attachment, a capstan lathe, a band saw and a number of drills and grinders of various types. One of the grinders is of the swinging frame type for surface work. Part of the shop is equipped with apparatus for electric and oxy-acetylene welding.

Woodworking Department

The woodworking department is accommodated in three buildings at the extreme northern end of the yard.

The saw mill is situated close to the fitting-out dock, the timber shed behind it and the joiners' and cabinet makers' shop on the southern side. The saw mill forms the central portion of a building having a total length of 175 feet and a width of 120 feet placed parallel to the dock. At the northern end of the building is a boat builders' shop which occupies a space measuring 120 feet by 71 feet; the saw mill measures 120 feet by 82 feet 6 inches and the greater part of the remaining portion, at the southern end, is utilized as a saw sharpeners' shop.

The only machine tools in the boat builders' shop are a saw bench and a drilling machine, most of the work in this shop being done by hand tools. Kilns are, however, provided outside the building, at the northern end, for steaming the planks preparatory to bending.

Saw Mill

The most notable appliance in the saw mill is a horizontal band saw for logs. This saw can deal with logs up to 4 feet square, and the timber carriage, as usually employed, is of sufficient length to accommodate logs up to 40 feet long. The carriage is made in two parts, which can be separated by 20 feet if necessary, and by this means logs up to 60 feet in length can be dealt with.

A circular saw bench with traveling table for logs and a heavy planing machine, which is largely used for planing deck planks, can deal with timber up to 16 inches by 8½ inches in section. Another planer to take work up to 30 inches by 9 inches and fitted with hand and power feed is in-

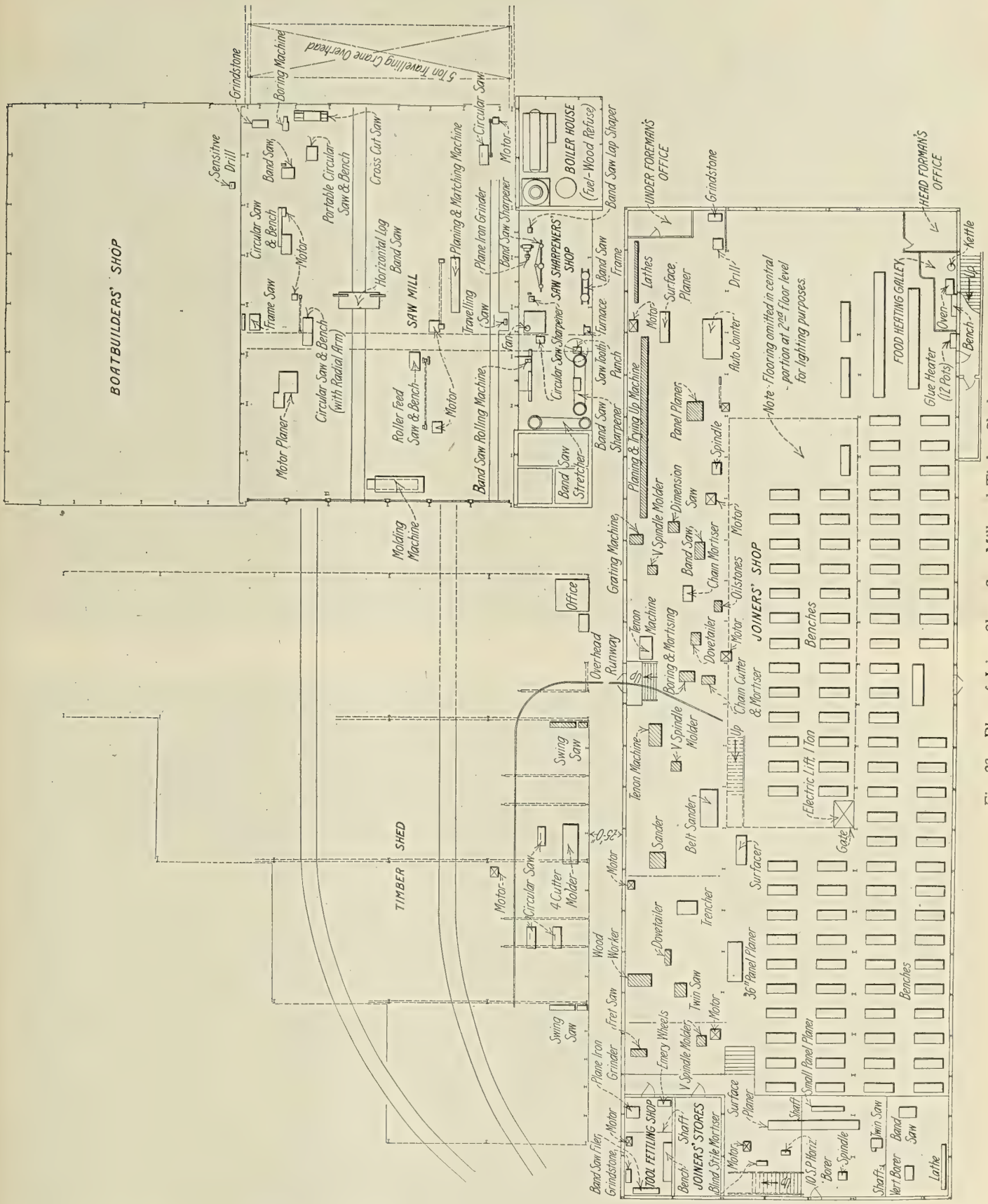


Fig. 23.—Plan of Joiner Shop, Saw Mill and Timber Shed

stalled and the equipment also includes a vertical log frame, a reciprocating cross cut saw, a band saw, two boring machines and a molding machine.

Dust and shavings are extracted by an exhaust fan which draws the dust-laden air from a pit to which the various machines are connected. The dust is used for firing a boiler which heats some of the adjacent shops.

The saw mill is served by a 5-ton overhead electric traveling crane of 80-foot span. The eastern end of the saw mill can be opened to full width to allow the crane to pass and the crane rails are extended on a gantry so that the crane can be run out over the dock to lift logs from railway trucks and to pick them up from the dock when delivered from barges on the river. The logs are taken into the saw mill by the over-

Fig. 24.—Plumbers' Shop, Pipe Bending Section

Fig. 25.—Power Station

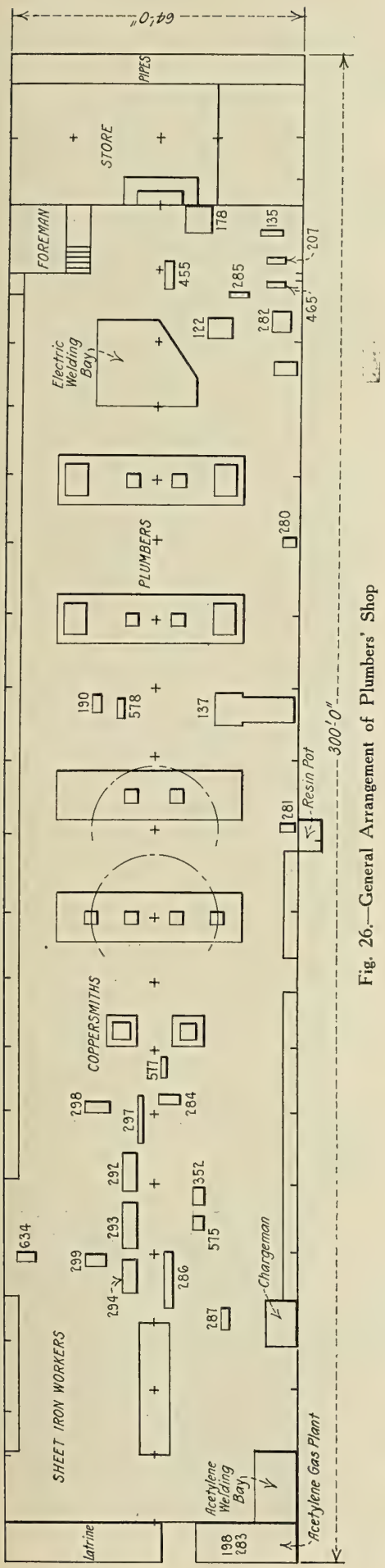


Fig. 26.—General Arrangement of Plumbers' Shop

Plumbers' Shop

MACHINES

Key No.	Description and Size
122	Tube sawing machine.
135	Screwing machine, ¾-inch to 4-inch pipes.
137	Hydraulic pipe bender, 18-inch stroke.
178	Horizontal drill.
190	Pipe filing machine.
198	Acetylene gas plant.
207	Screwing machine.
280	Blower.
281	Blower.
282	Grinder.
283	Acetylene gas plant.
284	Ball bearing drill.
285	Ball bearing drill.
286	Strong bender, 8'.
287	Two hand lever punches.
292	Power shears, 6' by 1/16".
293	Power shears, 8' by ⅛".
294	Multiple punch.
297	Plate bending rolls, 6'.
298	Hand lever cutting machines (four).
299	Punch and shears (hand).
352	Punch and shears, 12" gap.
455	Sensitive drill.
465	Screwing machine.
575	Power shears, 8' by ⅛".
576	Strong bender, 8'.
577	Tube sawing machine (for copper).
578	Pipe filling machine.
583	Pipe bender (hand), up to 2" diameter.
634	Pneumatic planishing hammer.
	Riveter.
	Hydraulic pipe flanger.
	Six plumbers' fires.
	Ten coppersmiths' fires.
	Bending slabs.
	Lathe, 6".
	Lathe, 9".
	Buffer.

head crane and the sawn timber is afterwards transferred to separate seasoning kilns for hard and soft woods by means of bogie railways.

Timber Sheds

There are four timber sheds, each 43 feet in width and ranging in length from 158 feet to 60 feet. After treatment in the kilns the timber is transferred to air-drying racks and there stored until required for use. It is then cut to lengths by pendulum and circular saws provided in the sheds and conveyed by bogie trucks and overhead runways to the joiners' and cabinet makers' shop, in which the whole of the joinery work and furniture, including chairs, required for vessels built at the yard is constructed.

Joiner Shop

The joiner shop is a two-story building 300 feet long and 100 feet wide. It is divided into three bays, of which the central one is 40 feet wide and the two outer bays are each 30 feet in width. The upper flooring is omitted in the central portion of the shop so as to provide ample light on the ground floor.

The machine tools are all situated in the bay on one side, while the bay on the other side is occupied with benches. The central bay may be cleared for erecting the work.

Among the more notable machines in the shop are planing and trying-up machines capable of taking timber up to 18 inches square in section, a panel planer which can deal with work up to 36 inches by 7 inches, a three-drum sandpapering machine for work up to 40 inches by 4 inches, and a planing and molding machine, with friction feed, which takes work up to 12 inches by 4 inches in section.

Other tools which may be mentioned are a 24-inch by 6-inch tenoning machine, two vertical spindle molding machines and a hollow chisel and chain mortising machine, a number of circular saw benches and band saws and a 10-spindle boring machine. Most of the tools are belt driven from line shafting carried on roller bearings, but some of the larger machines have independent driving motors.

Furniture constructed on the ground floor is taken by means of an electric lift to the upper floor where it is polished or otherwise finished and stored until required. The upper floor is also arranged to accommodate additional tools and benches for joiners' and cabinet makers' work.

Plumbers' Shop

The plumbers' shop is 300 feet in length by 64 feet wide. The northern end of the shop is used for sheet iron work, the central portion for coppersmiths' work and the southern end for plumbing work, while light sheet iron work, such as the construction of ventilators, ventilating trunks, casings, lockers and galley funnels, is also carried out on an upper floor at the southern end. The tool equipment includes a variety of pipe cutting, screwing and bending machines, shears and bending machines for sheet iron work, as well as punching and shearing machines, grinders, drills, etc.

A considerable amount of welding is done in connection with pipe work, both by the quasi-arc and oxy-acetylene processes.

Electrical Installation

The whole of the electric energy required in the yard is taken from the system of the Newcastle Electric Supply Company, so that no generating machinery is employed.

The electrical installation is, however, very extensive, as the total brake horsepower of the motors in the yard amounts to about 10,000 and electric energy is also used for lighting, welding, cooking and other purposes. Three-phase current is supplied at 6,000 volts and 40 cycles to three sub-stations in the yard, in which it is stepped down by static transformers to 440 volts for distribution to the shops. The sub-stations are conveniently situated, one near the western end of the

general stores building supplying the shops in the northern part of the yard, another near the head of the fourth building berth supplying the platers' shed and other plants in the neighborhood of the berths and the third in the power station building near the center of the fitting-out dock supplying the machinery in the power station.

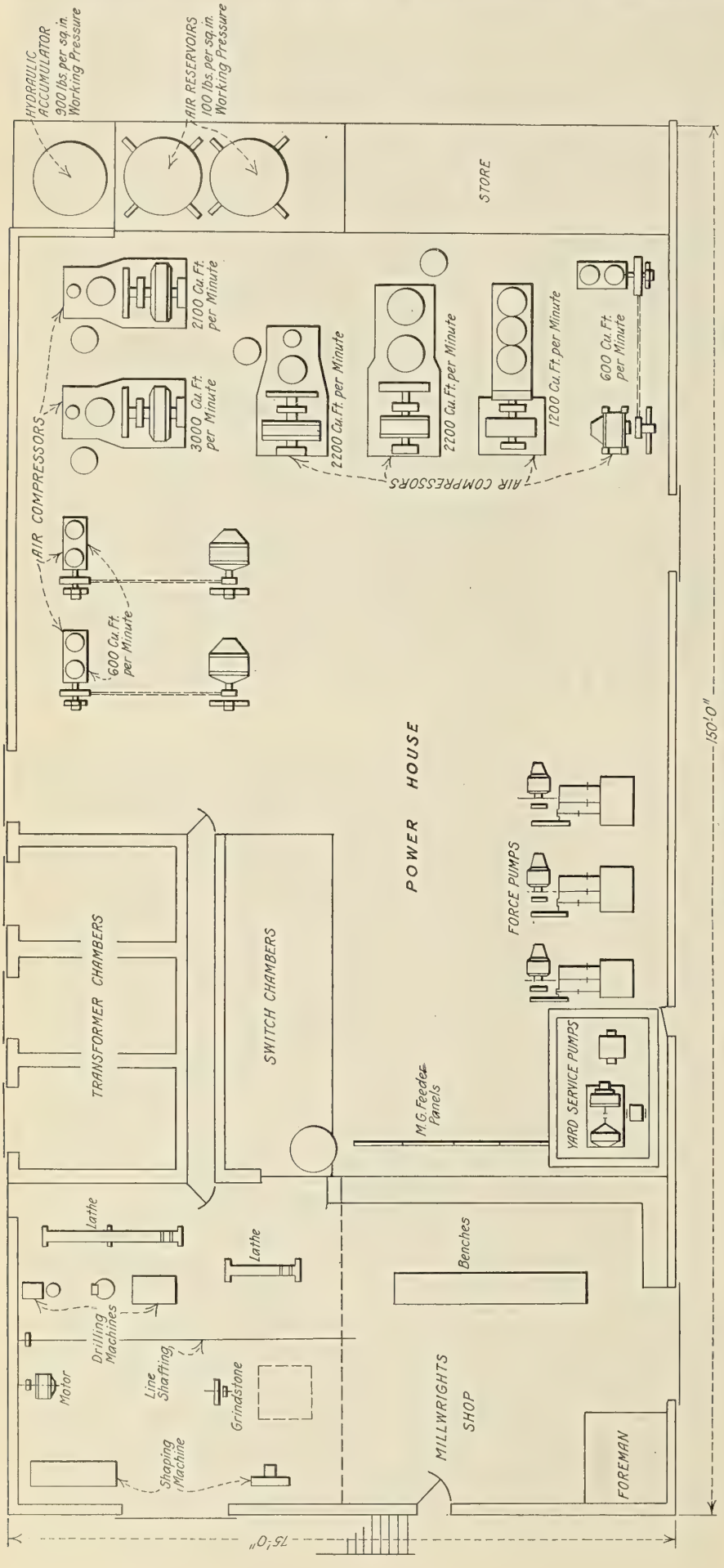


Fig. 27.—Plan of Power House

Power House

The power station building, which is used mainly for the supply of compressed air and hydraulic power, measures 150 feet long and 75 feet wide and is placed parallel with the fitting-out dock and near the center of the latter. A portion of the building, 38 feet in length, at the southern end is used as a millwrights' shop, in which general repairs to the yard plant are effected. The shop contains a few lathes, shapers, drills and other tools suitable for this class of work.

Air Compressing Equipment

The air compressing plant comprises eight electrically driven units. These supply air at a pressure of 100 pounds per square inch for operating power hammers, portable pneumatic tools and other appliances used in the yard. The largest compressor is capable of compressing 3,000 cubic feet of free air per minute and is directly coupled to an induction motor of 650 horsepower. A second machine, driven by a 400-horsepower motor, has a capacity of 2,200 cubic feet per minute and there is another compressor of the same capacity driven by an induction motor. Of the other compressors installed, two have capacities of 2,200 cubic feet and 1,200 cubic feet per minute, respectively, while the three remaining units are each capable of compressing 600 cubic feet per minute. The three small compressors are belt driven from Armstrong motors, while the other two machines are both directly coupled, the larger to a 400-horsepower motor and the smaller to a 260-horsepower motor.

Air is delivered into a vertical cylindrical receiver 30 feet long and 8 feet in diameter, placed in a separate compartment of the power station building at the northern end. From this it is distributed by 14-inch underground mains to all parts of the yard, the diameter of the mains diminishing to 9 inches at the most distant points. A 6-inch main, with branches at convenient intervals, is run down the sides of each of the large berths and arrangements are also made for the supply of air to vessels at the fitting-out dock. At various points in the yard where a particularly large demand for air occurs, such as the blacksmiths' shop and platers' shed, air receivers are provided of sufficient capacity to render the pressure fluctuations negligible.

Hydraulic Equipment

Hydraulic power is supplied by the three sets of pumps. These pumps, which are of Messrs. Armstrong's own

construction, are of the three-throw type and are each capable of delivering 90 gallons of water per minute against a working pressure of 900 pounds per square inch. They are driven through double reduction helical gearing by 75-horsepower motors, two of which were made by Messrs. Armstrong. The motors are automatically controlled by tappet switches actuated by the rise and fall of the accumulator, which is placed by the side of the air receiver in the compartment at the northern end of the building. The accumulator has a ram 18 inches in diameter with a stroke of 20 feet. Hydraulic power is distributed throughout the yard by 6-inch underground mains and the exhaust is returned by an 8-inch pipe to a tank in the power station.

The only other plant in the power station consists of two electrically driven centrifugal pumps which supply water for general use in the yard and also for testing tanks and watertight compartments of vessels under construction on the berths. These pumps, which are placed in the well shown in the foreground of Fig. 26, also circulate the cooling water for the compressors.

For use in connection with the overhauling and repairing of the plant in the power station, two 10-ton overhead traveling cranes operated by hand power are provided. One set of crane rails is extended into the millwright shop so that heavy machine parts can be transferred there for attention.

The Armstrong yard, being as it is the largest shipyard in England, occupies an important position among the prominent shipyards of the world, and the foregoing description gives an excellent idea of the completeness of the plant in every detail.

Cleaning Ships' Bottoms Without Docking

A SHIP cleaning plant has been developed by the Rapid Submersible Ship Cleaner Company, London, England, for scrubbing the underwater portions of the hull of a vessel while she is in port taking on or discharging a cargo. The complete plant comprises a steel boat 45 feet long, 11 feet wide and 5 feet 6 inches deep, which, when fully equipped, draws about 3 feet 6 inches of water. The boat is divided into three main compartments by steel watertight bulkheads. The forward compartment is arranged as a cabin for the crew of four men. The amidship portion is occupied by a winch and controlling gear for operating a submersible electrical scrubbing machine. The after part forms the engine room where a four cylinder kerosene engine of 45 brake horsepower is installed. This engine is direct coupled to an electric generator developing an output of 22 kilowatts at 100 volts. The engine also provides the power for propelling the boat through silent chain gearing to the propeller shaft. The vessel is

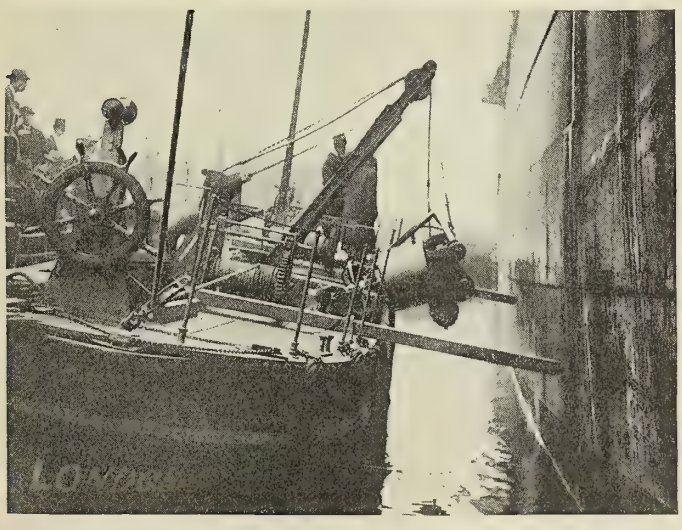


Fig. 1.—Submersible Ship Cleaner in Position for Lowering Against Side of Vessel to Be Scrubbed

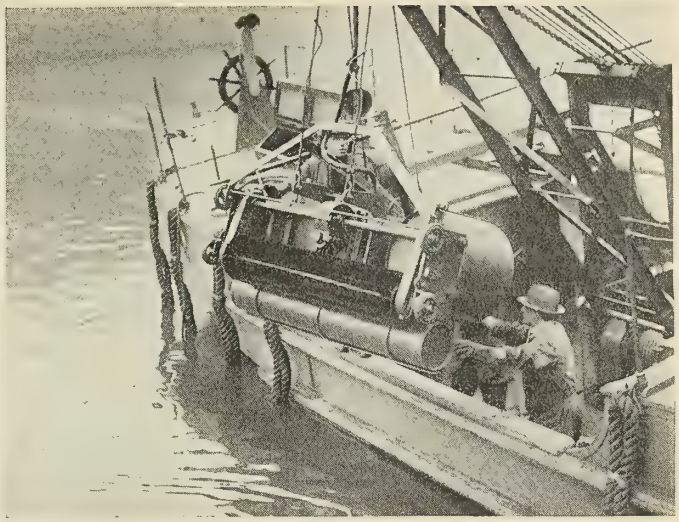


Fig. 2.—Arrangement of Scrubbing Brushes and Submersible Motor

equipped with electric light throughout, including powerful clusters for working at night.

The most interesting part of the plant is the electrical scrubbing apparatus, which consists of a steel frame to which a submersible electric motor of 12 brake horsepower is bolted. This frame also carries the scrubbing brush, which is circular in section and 5 feet long. The brush is made of coir fiber and brushes of varying degrees of stiffness can be used, according to the condition of the vessel operated on. The brush is revolved by the motor through suitable gearing. This motor also drives a bronze propeller which is situated at the rear of the brush; thus when the complete machine is lowered into the water at the side of a ship and the power switched on the circular brush revolves and is pressed firmly to the vessel by the thrust of the propeller. The whole machine is then lowered to the required depth and raised, brushing a strip 5 feet wide on the ship as it descends and rises. When the brush emerges the boat carrying the cleaning gear is moved about 4 feet and the operation repeated, until the whole length of the vessel has been scrubbed.

The scrubbing machine is raised and lowered by a specially designed electric winch with barrels for steel suspension wires and electric cable. The whole is controlled by one operator stationed near the boat's side. The scrubber is capable of removing any description of marine growth from the immersed part of a vessel and will do this without removing or injuring the paint on the vessel. If necessary, a special scrubber can be used and the whole of the vessel can be scaled of marine growths, paint, rust, etc., and left perfectly smooth and clean ready for repainting; thus the lengthy and costly operation of hand scaling is obviated.

Administrative Ruling.—Where the business on a particular trade route is adequately served by persons, citizens of the United States, with privately owned ships under American registry, or by Government owned ships in the hands of private operators under reasonable rates and conditions and free from unjust or undue discriminations or preferences, it is the policy of the United States Shipping Board not to establish or encourage the establishment of competing service on such route.

An Idle Merchant Marine.—The present situation in foreign exchange is not merely a matter of concern to international traders in securities. That merchant marine for which we waited for so many years is either tied up in port or is sailing for Europe in ballast. We have the tonnage. The time has come for supplying European buyers with the credit necessary to use that tonnage. Otherwise our plan for becoming a great maritime nation will prove just an empty dream.

Standardized Diesel Engines*

Harmonious Combination of Essential Diesel Engine Requirements with American Practicability

BY H. R. SETZ

SINCE Diesel engines have come into more general use in the United States, marked diversities in technique of design and manufacture have become apparent. On one hand we see established European types of engines copied in every minute detail and dimension with an uncritical exactness which indicates a complete lack of perception for their peculiarities and limitations; on the other hand, there is a tendency indiscriminately to discard the refinements and seemingly expensive constructive details characteristic of all successful Diesel engines in favor of the cheap and inadequate practices that dominate ordinary gas engine, and even steam engine construction. The former leads to excessive cost due to unsuitability of many details to American shop methods and operating conditions; the latter results in rapid deterioration and complete failure under anything like the operating requirements which modern Diesel engines can meet.

In what follows a line of engines is described that represents a comprehensive effort at a harmonious combination of essential Diesel engine requirements with American practicability. As the outstanding feature of the latter the author perceives the endeavor of standardization in the sense of adopting recognized constructive elements to the greatest possible variety of applications compatible with accepted engineering principles. The Diesel engine is essentially simple, whether built in the four cycle or two cycle type, and the following expositions show that this simplicity can be given extremely practical expression through the channels of standardized design, if conceived broadly enough from the outset. It will also be seen that neither in the four cycle nor in the two cycle form does this standardization demand departure from accepted Diesel engine technique, but rather to the contrary that such procedure is conducive to the attainment of results which without it seemed far beyond practical realization.

The aggregate capacity of four cycle Diesel engines in operation today in all parts of the world amounts to well over three million horsepower. This formidable output is obtained from engines ranging from only a few horsepower per cylinder up to units where 400 horsepower are being developed in one single cylinder. Their field of application covers any requirement where power is needed at a steady enough rate to justify their comparatively high first cost. With very few exceptions, Diesel engines are not found in places where power requirements are of a seasonal or such fluctuating nature as to result in a low average load factor and there are very compelling economic reasons why their application gravitates preponderantly towards fields of heavy and essentially continuous power demand such as central station work and marine installations.

As a result of such severe and diversified application extending over a period of approximately twenty years of steady and progressive development, the principles peculiar to successful four cycle engine construction have become well established. In the application of these principles from the viewpoint of standardization, it is not necessary to cast about for fundamentally new forms, as existing types of engines present a wide and rich choice of constructive features which have the makings of a standardized product.

General Engine Structure

Beginning with the frame structure, there has come into increasing use for all advanced service requirements, such as marine installations, a construction consisting of the bed plate, vertical frame members and a beam-like top member mounted over the latter which serves as a support for the cylinders. The widest and most consistent application of these features is embodied in the modern Burmeister and Wain engines, where the top member or cylinder beam takes the form of a deep box section which surrounds the cylinders over their entire length. The extreme rigidity obtained with this construction has to no small part contributed to the success of these engines.

In a broader conception this same general frame structure forms the basis for the engines dealt with in this article, the principal modification consisting in the method of mounting the cylinders. In the Burmeister and Wain engines bored seats are provided directly in the cylinder beam for the top and bottom ends of the cylinders, thereby providing one fixed position for each cylinder relatively to the common beam. Since such a beam contains from two to four cylinders it becomes a rather bulky and heavy casting in which requisite accuracy for the cylinder seats, particularly as regards parallelism of the cylinder centerlines, cannot be readily obtained. Proper alinement of the cylinders with their respective cranks depends entirely upon this point. Corrective measures for errors in machining are difficult to apply. The delicacy of this boring operation in so large a piece can therefore be readily appreciated and a modification which eliminates this operation is thoroughly desirable from a manufacturing point of view.

The seating of the cylinders at their extreme ends directly in the beam requires so close a spaced relation between these parts that the accommodation in the same beam of a variety of cylinder sizes or types is practically excluded. So far as considerations of strength and rigidity are concerned—the main reasons for the use of a cylinder beam—a very much freer relation between these parts is permissible. The elimination of bored cylinder seats therefore suggests itself as a means for securing wider adaptability for so large and expensive a piece as this beam.

A-Frames and Tie Rods

Fig. 1 shows a frame structure in which the foregoing considerations have been given due regard. The vertical frame members take the form of A-frames which are mounted on the bedplate in the plane of the main bearings. The deep, box-shaped, cylinder beam rests on top of the A-frames and is secured to the latter by means of tie rods of such length as to insure the transmission of forces well into the structure of the parts which they connect. For this purpose each tie rod is carried from the top of the cylinder beam to a point in the A-frame where the distribution of material insures most favorable stress distribution, and from this point on down the cross-sectional development of the A-frames easily permits direct force transmission into the bedplate.

A rigid method of fastening is thus obtained which does away with the inconvenience of a great number of flange bolts at so inaccessible a place as is found where the top of the A-frames joins the underside of the cylinder beam, and, due to their comparative shortness, elastic deformations in the tie rods can be kept within practical limits without having to resort to excessively heavy sections. The deformation of the lower part of the A-frames, such as is easily possible by careless tightening of tie rods which run clear through to the

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underside of the bedplate, is also made impossible. These short tie rods, furthermore, permit of easier handling in erection and overhauling of the engine, particularly in tight places such as on board ship. Being shorter than the height of the A-frames, they can be lowered and temporarily secured so as to be contained entirely within the A-frames and removed with these sideways from underneath the cylinder beam. The crank shaft is bedded deep enough in the bedplate to clear the underside of the A-frames, thus readily permitting of their sidewise removal without disturbing any other engine parts. This is a feature which contrasts very favorably with some of the expedients recently adopted for accomplishing similar results.

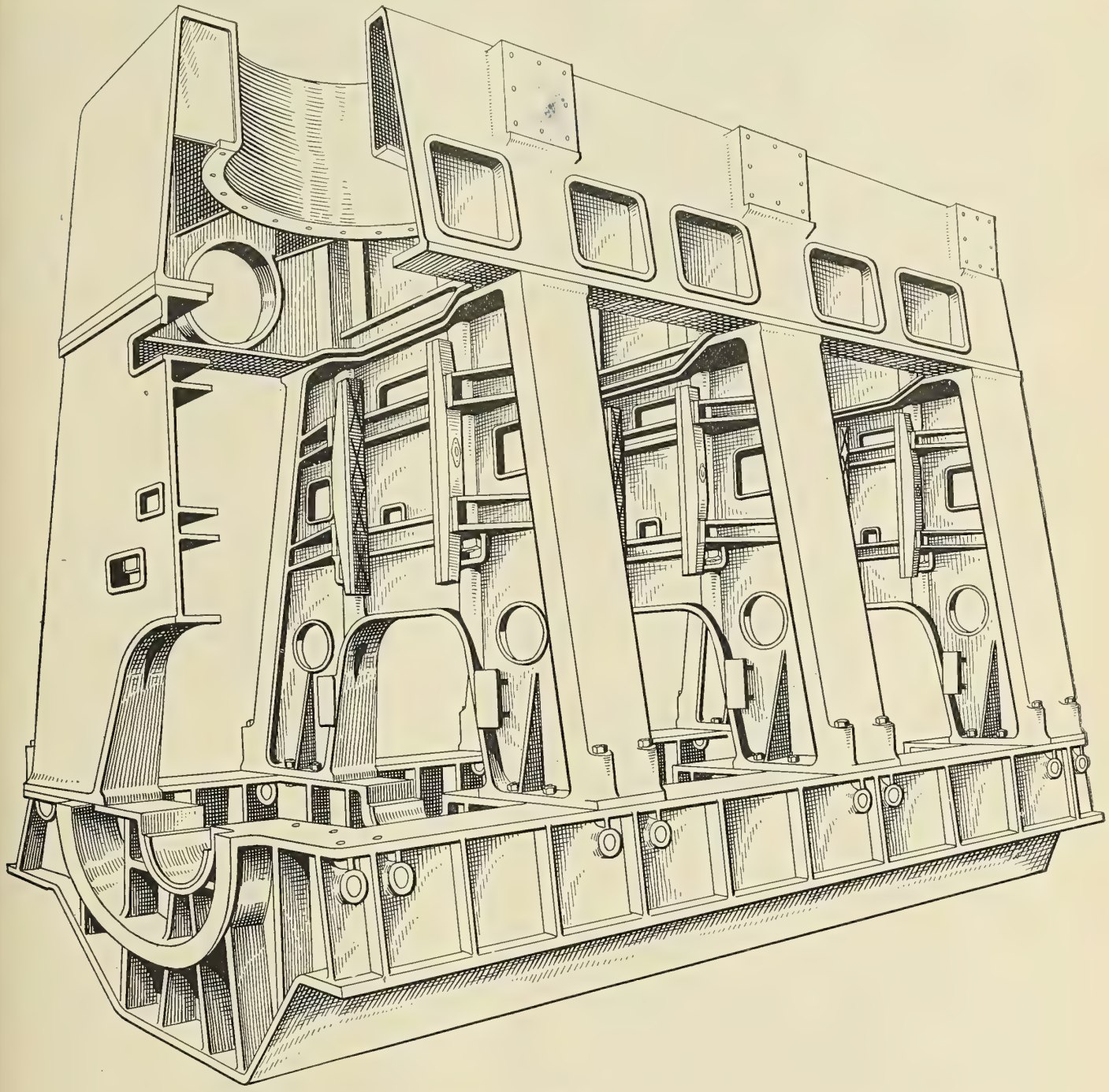


Fig. 1

Cylinder Beam

The cylinder beam, running the whole length of the engine, effectively braces the upper ends of the A-frames and forms the bridge between the centerline of the forces due to the working pressures in the cylinders and the re-acting forces of the main bearings. The working forces of the engine are therefore transmitted to the bedplate in the planes of the main bearings and longitudinal bending of the bedplate is thereby eliminated. What bending there is occurs in the transverse girders of the bedplate and is only of slight amount, namely, that determined by the amount of span in the arch of the A-frame required to straddle the main bearing caps. The elimination of all considerable bending deflections from that part of the engine structure which contains the delicate and important working surfaces of the main bearings and the accommodation of these strains in so favorably proportioned a piece as the cylinder beam is a matter whose importance cannot be overestimated, especially for marine engines.

In the cylinder beam shown in Fig. 1 no provision is made for bored cylinder seats and all machining processes on same are reduced to ordinary facing and drilling operations without calling for any particular degree of accuracy. Its function as a load transmitting member is reflected in its deep box

section, augmented by the tubular extensions of the cylinder openings which project well into the interior of the beam. Exceptional rigidity is thus obtained at a minimum expenditure of metal.

CYLINDER SEATS

The cylinder seats are located in separate flanged rings (see Figs. 2 and 3) which can be conveniently bored to any desired degree of accuracy on a lathe or vertical boring mill. The upper ring, into which the cylinder proper is inserted in the usual manner so as to be rigidly held with the cylinder head in place, rests with its flange squarely on the top of the beam. The bottom ring is slidably fitted over the lower end of the cylinder and bolted against the flanged face at the lower end of the tubular opening which runs parallel to the top face of the beam. The cylinder passes through this tubular opening with considerable clearance, thus forming a large water jacket space which the upper and lower cylinder rings close off; this also permits of independent lateral movement of each cylinder relatively to the cylinder beam, thereby making possible the convenient and exact alinement of each cylinder with its respective crank. After having been properly located the flanges of the cylinder rings are dowel pinned, which definitely centers the cylinders.

BEDPLATE

The bedplate is a rigid casting consisting of longitudinal and cross girders of deep I-section with wide flanges on top and bottom, which are effectively reinforced by suitable ribs. The cross girders carry the main bearings in bored seats. The whole engine bedplate is made up of symmetrical sections, each comprising two or three cylinders, for the main part and the narrower compressor section at the forward end (see Fig. 3). The bottom of the crank pit under the main sections is formed by one continuous welded steel pan of any desired depth to meet particular conditions, and, owing to the fact that the bolts which hold this pan in place are accessible from the interior of the bedplate, it becomes possible to maintain an oiltight joint after the engine is erected.

MAIN BEARINGS

The main bearings take the form of babbitted cast iron shells, readily rolled out of their bored seats without requiring removal or even lifting of the shaft. Except in stationary engines, where one of the center shells is made slightly longer so as definitely to locate the shaft axially, all shells are of the same length and interchangeable. With the exception stated, all these shells have liberal end clearances to permit axial expansion of the shaft relatively to the cooler bedplate. The A-frames rest with broad flanges on the bedplate and ample space is provided for accessibly locating through bolts of liberal proportions. Their design is such that for a given cylinder group the extreme end frames are alike and interchangeable, as are the frames between cylinders. In this manner only two patterns are required and only two kinds of castings need be carried in order to cover any number of cylinders that may be required for a complete engine. A conspicuous feature of this frame arrangement is the wide openings through which ready access can be had to the interior of the engine. Flanged edges along the outside contour of the A-frames facilitate the convenient placing of oiltight doors.

CROSSHEADS

For heavy duty service, and for marine installations in particular, the use of crossheads is coming into more and more general use. Experience has taught that their slight extra cost is offset in a short time by reduced wear and the greater ease of maintaining exact clearances on those parts which are subject to sliding wear. This is so well understood today that it requires no further comment, although it may be mentioned in passing that leading European builders are today applying

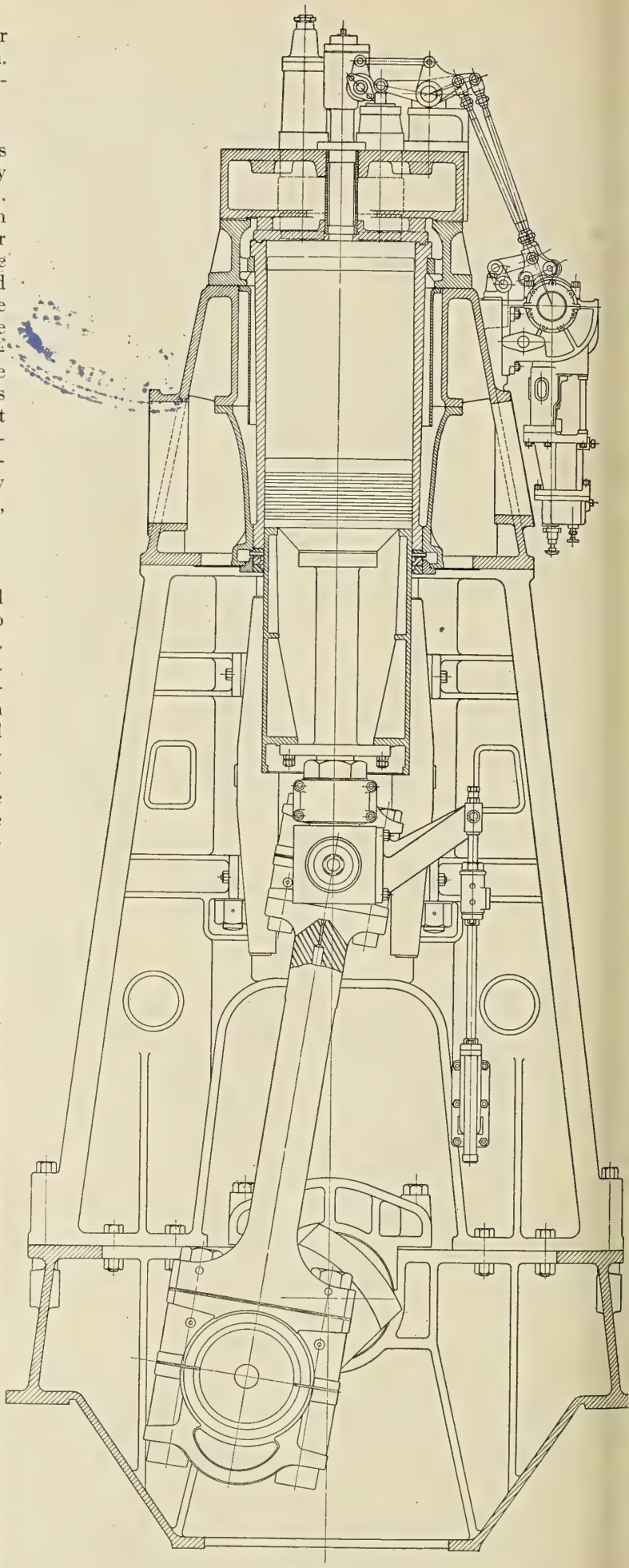
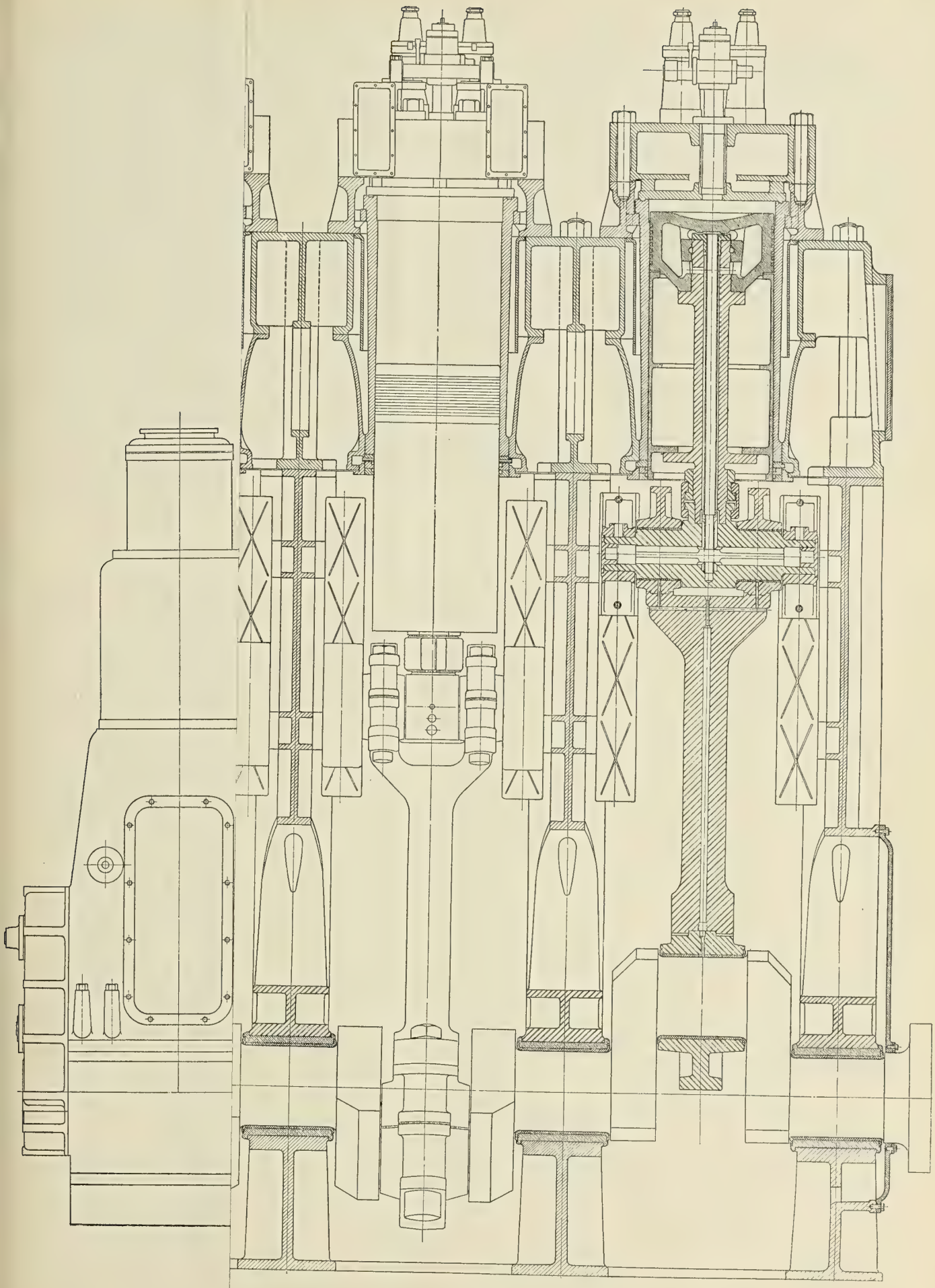


Fig. 2



STANDARDIZED DIESEL ENGINES

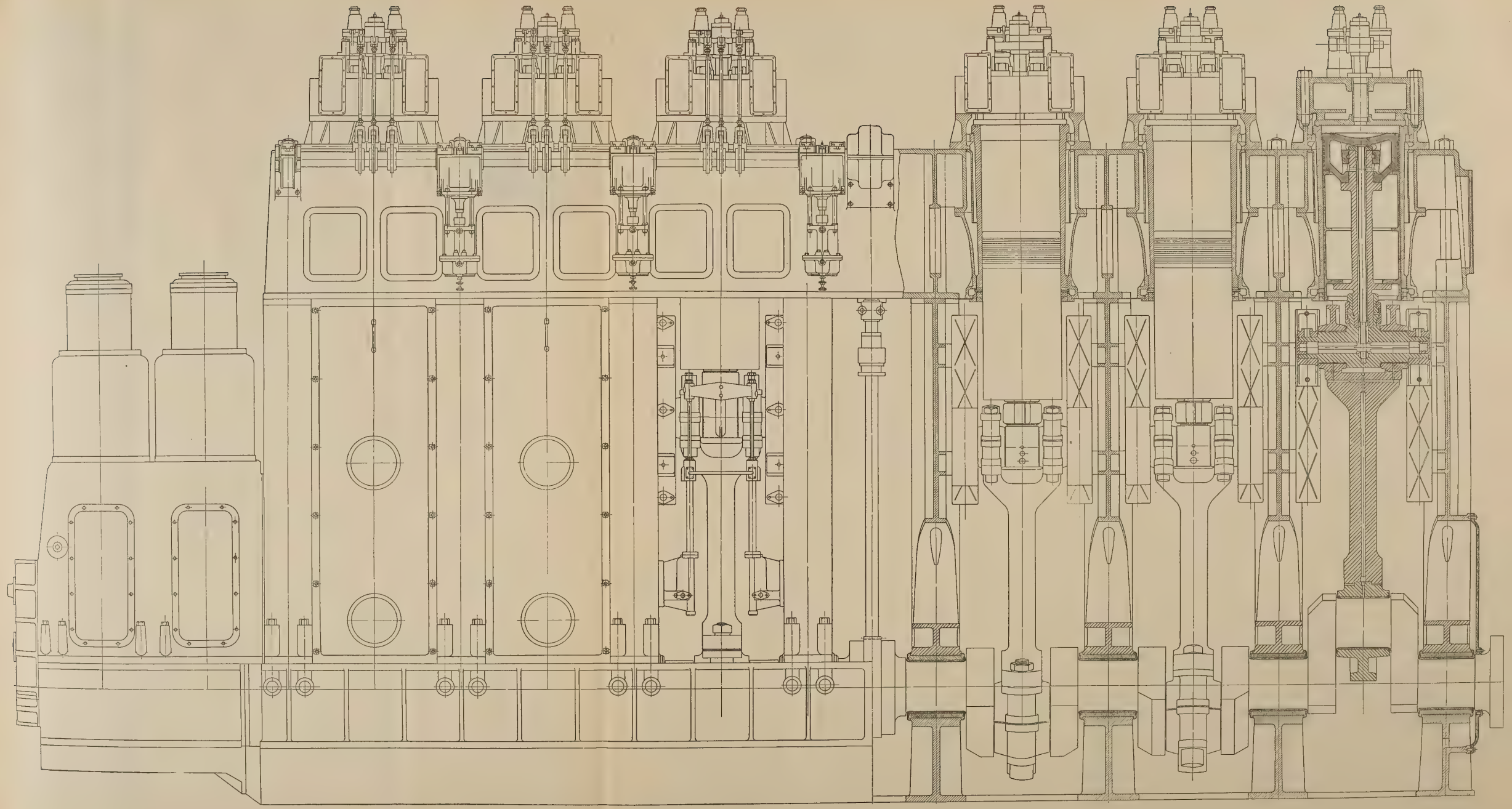


Fig. 3

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crossheads to four cycle marine engines of as low as 17 inches cylinder bore, a practice which only a few years ago was considered superfluous and commercially impossible. There are very good reasons why American marine engineers ought to heed this tendency.

As to the type of crosshead to be used on Diesel engines, there still exists today a very considerable diversity of opinion. With very few exceptions the types and general arrangement of crosshead constructions bear the earmarks of their origin, the steam engine. Center crossheads, running in bored guides, was the first form used in Diesel engines. Their inconvenience in manufacture, however, especially in larger units, and more so their limited accessibility and inadequate means for adjustment for wear, have failed to make them very popular. From this form it was only a short step to the center crosshead with flat guides such as are extensively used on marine steam engines. Here provisions can readily be made for adjustments, and considerable accessibility, also, can be obtained if the frame columns which carry the crosshead guides are placed in the plane in which the connecting rod swings. This latter requirement, however, successful as it has proved to be with steam engines, is a serious detriment when applied to Diesel engines. Since the full working forces are transmitted through these columns into the bedplate, the latter is subjected to heavy longitudinal bending moments, and, on account of the necessarily wide span required for clearing the path of the crank pin boxes, also to very considerable transverse bending stresses.

Side Type Crosshead

Another type of crosshead adopted for Diesel engines is the side crosshead, most extensively used on marine steam engines. Its comparative freedom from temperature influences and, not the least, its cheapness are the features which have given it this wide popularity. The front column only is made use of to carry the crosshead guide; inasmuch, however, as this column is still placed in the plane of connecting rod, its use is just as unfavorable for load transmission to the bedplate of a Diesel engine as the previous one. It was, however, through adaptation of the side crosshead to practical Diesel engine requirements that the first really successful crosshead type marine Diesel engine came into existence. We are referring to the Burmeister and Wain construction where independent A-frames are mounted over the bedplate in the plane of the main bearings with the crosshead guide extending from one to the next of these A-frames.

This is no longer as simple an arrangement as the side crosshead used on the steam engine. The fact that the one guide for each crosshead is supported on two entirely separate frame members introduces a rather delicate erection job on large pieces and in positions which require no small amount of painstaking care. Probably the least desirable feature, however, is the fact that the crosshead side of an engine so constructed is practically entirely closed off as far as convenient access into the interior is concerned, a matter of no small consequence from the operating point of view. This arrangement is, of course, also objectionable from the viewpoint of standardization, since the resulting departure from symmetry about the center plane of the engine requires right and left hand or inboard and outboard parts.

Double Center Crosshead

Considerations of this nature have brought increasing favor to the so-called double center crosshead. Having originated in large steam engine practice, it is coming into more general use on Diesel engines and has been adopted for the line of engines here described. The two crossheads at the end of the crosshead pin (see Figs. 2 and 3) are entirely symmetrical and interchangeable. Each carries a pair of babbitted, interchangeable slippers which can easily be removed without disturbing any other parts when wear makes readjustments necessary. The side thrust from these crossheads is taken up by water-cooled guides of plain box-shaped cross-section, and requirements of strength and rigidity, as well as ease of alinement, are met by the provision of two supports for each guide at the points of maximum side thrust.

These supports take the form of deeply ribbed brackets cast integral with the A-frames (see Fig. 1). Splitting the side into two halves has the double advantage of making possible the use of a larger aggregate surface and of greatly improving accessibility from both sides of the engine. The four guide rails (Fig. 18) can readily be so placed as to allow the downward withdrawal of the piston. When it is remembered that the pulling of the piston upward sacrifices headroom, makes necessary the complete dismantling of pipes, tubing and valve gear, not to mention the wasted time and labor incident to the disturbance of adjustments and roller clearances, the advantage of the arrangement can be appreciated.

The removal of the pistons from below is further facilitated by the absence of any partition separating the underside of the cylinders from the crank case. In order to prevent the dripping of carbonized oil residues which will work past the pistons and would drop into the crank pit below, a light tubular piston extension is used from which excess oil and residues are scraped off by two inwardly closing snap rings in the lower end of the cylinders. A small annular chamber surrounding these scraper rings serves as a receptacle for the oil thus collected.

This arrangement, it will be observed, is identical with the most accepted practice on modern two cycle engines. Considering the total forces that have to be dealt with here the slight extra weight added to the reciprocating masses by the piston extension is of hardly noticeable consequence; on the other hand, the absence of a partition underneath the cylinders results in reduced engine height, an incidental feature which for certain installations is of considerable importance.

The Piston Rod

The piston rod is hollow and serves with its integral top flange not only as a support of the piston but also conveys cooling water to and from the latter. By means of a telescope tube all the water is first conducted to the crosshead where a baffle plate forces it to flow through the whole length of the hollow crosshead pin before reaching the central bore which communicates directly with the hollow piston rod. Similarly, the discharge is conducted through a central tube in the piston rod directly to the crosshead pin and thence out through a second telescope tube.

In order to make possible such a well directed flow of cooling water, and for other reasons which will become more apparent later on, the piston rod is secured to the crosshead pin by means of a split collar backed by a heavy nut on the threaded end of the piston rod. The absence of any fastening means whatsoever on the underside of the crosshead pin permits the upper end of the connecting rod between the two crosshead pin boxes to be made exceptionally substantial and rigid.

In recognition of the importance of preventing cooling water leakage into the crank pit, particular care has been given to the packing of the telescope tubes. Aside from self-adjusting metallic packing rings, an air seal is used which is kept under a pressure of from twelve to fifteen pounds per square inch from the first stage of the air compressor. With a negligible consumption of air, leakage water past the packing rings is prevented from passing the air seal. This arrangement combined with non-corrosive telescope tubes makes possible the use of sea water for piston cooling, thus greatly simplifying the whole cooling water circulating system as compared with such arrangements which require fresh water piston cooling.

Where there are more than three cylinders in one engine the crank shaft is made in symmetrical sections of two or three

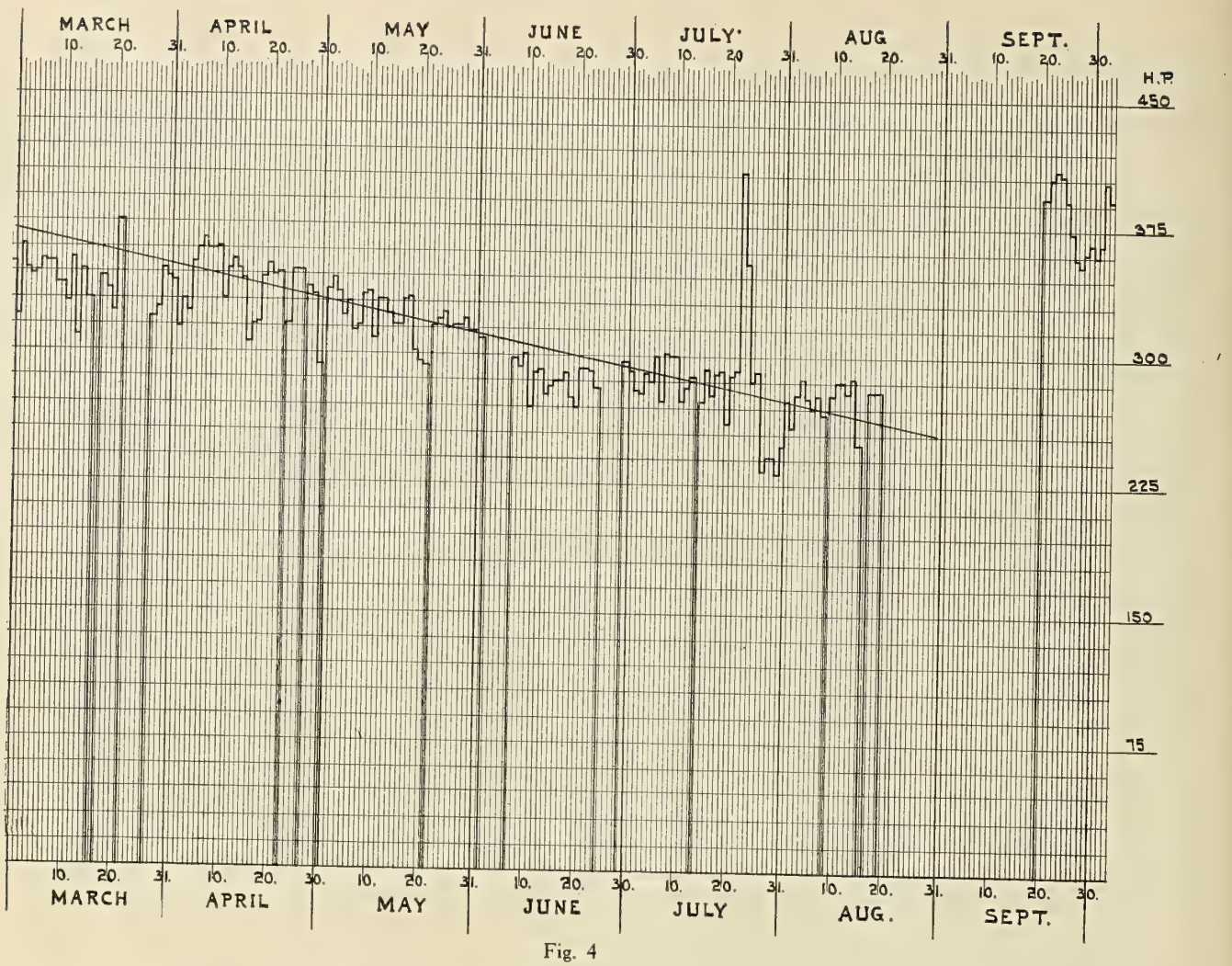


Fig. 4

cranks per section, reversible end for end; the flanged joint is placed between the two middle cylinders in the same plane with the joint in the bedplate. Each main bearing is supplied with lubricating oil under pressure through an indicator, where not only the actual flow can be observed but also measured and regulated; an automatic alarm gives warning when the supply to any bearing reaches a minimum. Crank pin and crosshead pin boxes as well as crosshead shoes are supplied with pressure oil in the usual manner through drilled holes in the shaft and connecting rods.

Water Cooling

In considering any type of engine structure, too much emphasis cannot be laid upon the facilities which are afforded for insuring adequate water cooling of the cylinder and cylinder heads. Adequate water cooling implies not merely the presence of a body of water in contact with the heated surfaces, but also that it will be in active and well defined circulation over these surfaces. The rate of heat transmission between the surfaces and water which is agitated and in motion is appreciably higher than if the water is flowing very gently; sluggish flow causes precipitation of mineral deposits, thereby further imparing the transmission of heat. Low mean temperatures of the casting walls are highly desirable for reducing heat distress, for improving lubrication and for maintaining the volumetric efficiency of the engine. To what extent this may affect actual operating results can be seen with unusual clearness from the record of a three cylinder, four cycle, 450 brake horsepower Diesel engine of conventional heavy duty design.

Fig. 4 shows graphically the average daily output of this engine, covering the period from the month of March until the following October; the engine was put in operation the previous June. This particular engine was one of several other units in a station where the load conditions are practically steady and continuous and where, on account of the superior economy of the Diesel engine compared with the other units (steam), the former was uninterruptedly kept loaded to its highest possible capacity. About six months after this engine was put in service it became apparent that its capacity was falling off, which manifested itself by increasingly smoky exhaust at loads below the maximum rated load and, if forced, in overheated and seized pistons (trunk pistons, uncooled). Gradually this condition became worse, and in March, where our diagram begins, 350 brake horsepower was about as high a load as it was deemed safe to carry. On March 21 and 22 an attempt was made to put more load on this engine, with the result that the piston seized and required regrinding, hence the shutdown of several days.

The continued dropping off in load capacity at an average rate of approximately 15 horsepower per month was rather puzzling at first, especially in view of the fact that all the valves were kept in satisfactory condition, which is borne out in the chart by the steady runs that were being made, as high as 646 consecutive hours by the actual station log. From all the surrounding circumstances it gradually became apparent that the trouble was due to heat distress. This was verified on July 22 and 23 when arrangements could be made to circulate an extra large quantity of cooling water through this engine. A load about 50 percent higher than the then prevailing average could be carried for 37 consecutive hours.

When it finally became possible to shut this engine down for a thorough inspection and overhaul, a mineral deposit was found on the cylinders and cylinder heads which in places

was fully ¼ inch thick. The diagram shows to what extent operating conditions were improved by the removal of these deposits; a load up to within 90 percent of the full rated load could be carried without any signs of distress, and that in spite of the fact that neither cylinder liners nor pistons were anywhere near in normal condition after the previous hard usage.

Water Jacket Areas Should Be Restricted

Experiences like these, and the considerations already referred to, account for the increasing tendency to depart from the "liberal" water spaces still occasionally emphasized in the trade literature. Water jackets should be designed from the very opposite point of view, namely, that of restricting areas.

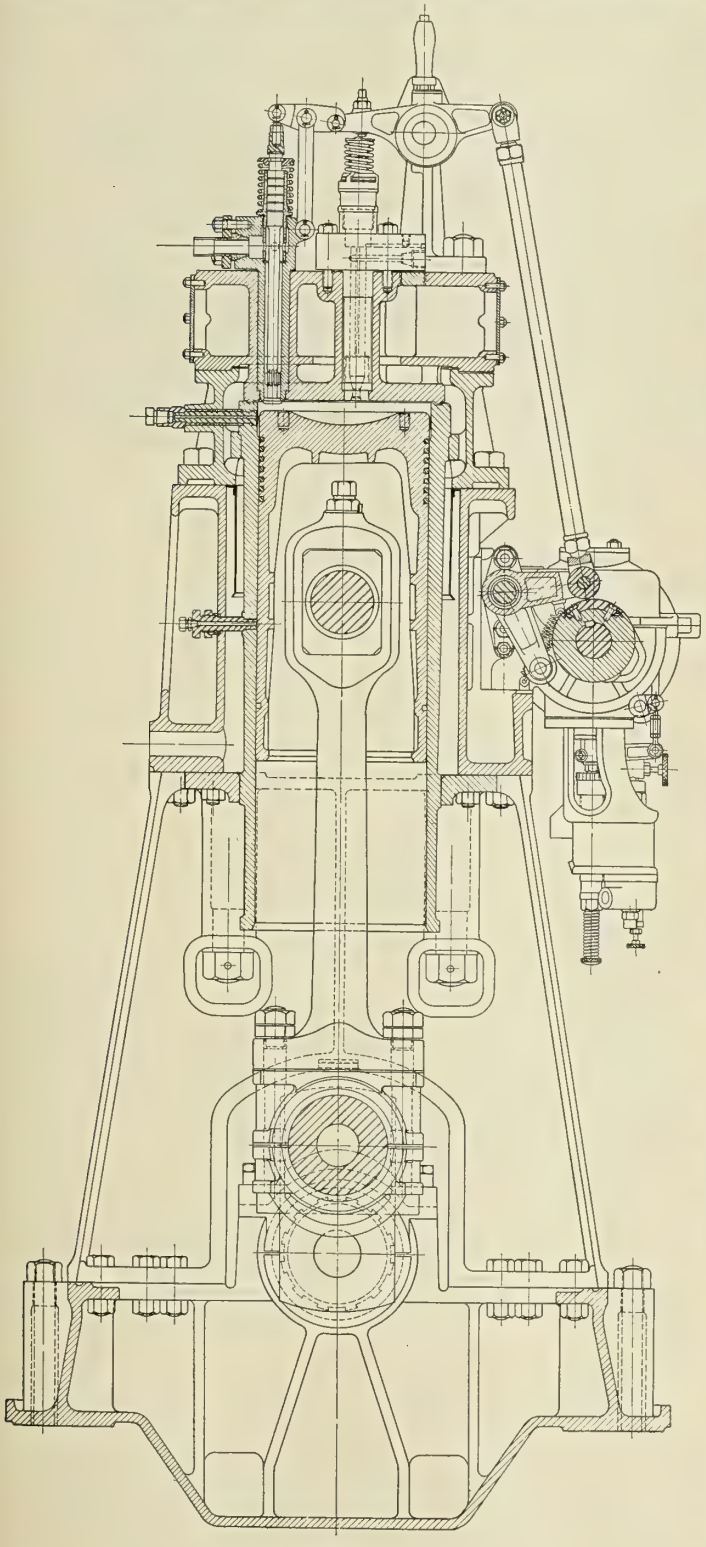


Fig. 5

This should be done especially in the neighborhood of more highly heated cylinder parts, over which the water must be forced to flow at a velocity high enough to insure rapid heat transmission and by mechanical agitation to forestall the deposit of minerals. The cylinder beam construction as illustrated in Fig. 1 lends itself particularly well to the conscientious observance of these principles. As may be seen from Figs. 2 and 3, it is a simple matter to secure under the flange of the upper cylinder ring a barrel-like baffle which forces all the cooling water actively to circulate around the cylinder in a thin sheet.

The same idea is carried through in the design of the cylinder head. Since this is provided with a baffle plate in the water space immediately above the combustion chamber wall, all the cooling water is caused to pass over this heated wall at a fairly high velocity, which increases towards the center where the most intense heat conditions occur around the fuel injection valve. This feature is obtained without undue complications to the cylinder head casting. A part of its jacket wall is formed by the upper cylinder ring, a construction

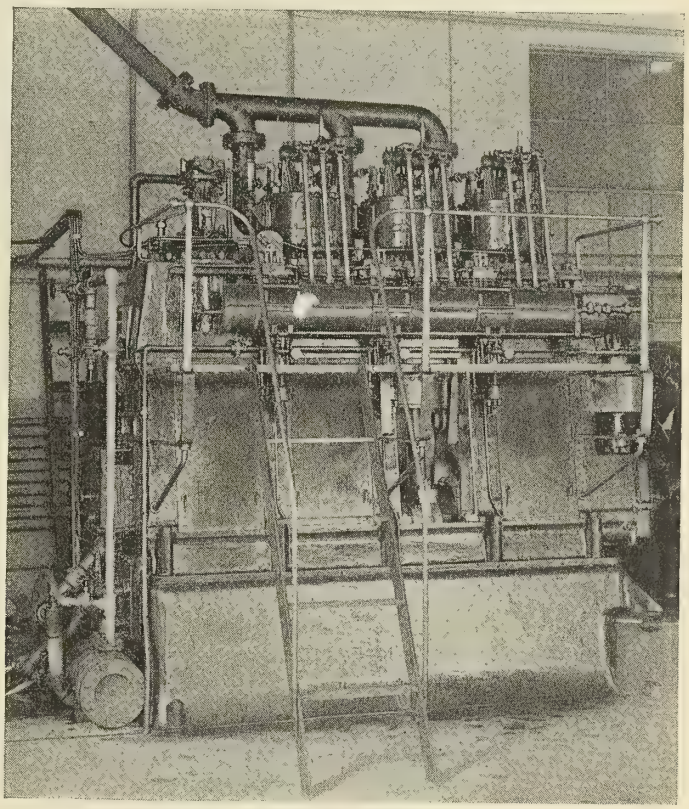


Fig. 6

which makes the narrow water passage space accessible all around from underneath for core work and cleaning. The intensification of cooling due to the flow of cooling water around the outer edge of the cylinder and cylinder head wall contrasts favorably with those constructions in which these walls take the form of heavy flanges that are touched by the cooling water only on the top and bottom respectively. The cylinder head studs can be so placed as to permit their convenient packing against coming into contact with the cooling water, a consideration of importance for salt water service.

Three Cylinder Trunk Piston Engine

Fig. 5 shows the transverse section, and Fig. 6 shows a photographic view of a three cylinder Diesel engine in which the foregoing ideas as to frame construction, cylinder mounting and cooling have been incorporated. The ease of manufacture, beginning with the simple castings, the convenience of machining and the ready accessibility in erection were mat-

ters of general comment. This being a trunk piston engine, with the connecting rod side thrust transmitted directly into the cylinders, it afforded a good opportunity to test the rigidity of its frame structure. As was to be expected from the favorable cylinder mounting, the elastic deformations so typical of high speed engines are minimized to an extent which makes the engine practically free from vibrations. Since this is the largest single factor that affects maintenance of the accurate alinements required by Diesel engines in order to reduce wear, the advantages of this arrangement can readily be appreciated.

The provisions for efficient cooling have likewise met all expectations. There is a just barely perceptible temperature increase on the external cylinder and cylinder head walls even under the heaviest loads; the pistons run exceptionally cool and the lubricating oil which works down between cylinders and pistons is entirely free from carbonized residues. The rapid circulation of cooling water over the cylinder head causes extremely efficient cooling around the various valve cage seats; as a result the cages themselves as well as the valves are kept at so even a temperature under all operating conditions that clearances of the valve gear parts can be set with a degree of closeness that insures quietness and ease of operation at highest speeds.

(*To be continued.*)

The United States Will Lead in Motorship Building, Predicts Dr. Lucke

AMERICA will lead the world in motorship development just as she does in the motor car industry, Charles E. Lucke, professor of mechanical engineering at Columbia University, predicts in a survey on the relative merits of motorships and steamships made for the American Society of Mechanical Engineers.

Professor Lucke, who during the war was director of the United States Navy Gas Engine School, a Columbia University war institution, which trained crews to man submarine chasers in European waters, asserts that this country is entering upon a programme of motorship construction and that although this industry developed in Europe the leadership in building and operation will eventually pass to America. He points out that the history of the motor car industry is likely to repeat itself in the motorship. At the outset Europe led in that industry, but as the art developed the primacy shifted to this side of the Atlantic.

Rising Costs Have Increased Motorship Building

Dr. Lucke says that rising costs due to the war have increased motorship building at the expense of steamship construction and that future conditions so far as they can be forecast favor the motorship over the steam vessel as a vehicle of ocean commerce.

"European shipbuilding nations," states Professor Lucke, "the Scandinavians at first, but now practically all, including England, France, Holland and Italy, in addition to Germany, have for some years been building large Diesel engines and auxiliary equipment for the driving of seagoing vessels. In more recent years this movement has been accelerated by the proved economy of the equipment that has been found most reliable and the reduction in cargo-carrying costs by the motorship over the steamship. The raising of all prices and costs by the war has directed attention to every possible source of saving, and this, among other things, has further increased the volume of motorship building at the expense of steamship construction.

"During this whole period of experimental development of the propelling machinery, and with its perfection the large-scale demonstration of lower cargo-carrying costs over competing steam equipment, America has done nothing with the motorship. On the contrary, there has been a great increase in steam cargo carriers, first as a result of war demands and later as a national movement for the re-establishment of the American merchant marine in a position of some commanding importance at sea.

European Countries the Pioneers

"While America has been building more and more steamships, the Europeans have been building fewer, in proportion, replacing them by motorships, partly on the basis of demonstrated reliability, but mainly on the basis of proved reduction of operating costs. Only now have our shipping interests passed the period of consideration and entered upon that of action.

"It has taken some years to convince American shipping interests that the motorship is reliable; it has taken some years to convince these same interests that America can build satisfactory engines and that they need not be reproductions of European models; but it can be said definitely that shipping interests have now reached the point of accepting this situation. It is admitted that American Diesel engines can be built equal in quality to those built in Europe and also at competing costs, but in spite of this there has not as yet been any great adoption of the motorship in this country. Only a few have been contracted for today, although a great many projects are under consideration.

The Problem of Using Lower Grade Oil

"To adapt the motorship to the burning of the lower grade oil, which seems to be really the only step necessary to eliminate even the residual doubts remaining in the minds of American shipping interests, there are only two factors of any importance to be studied, namely, spraying of the oil and ignition temperatures.

"It may be said, therefore, that America is about to enter on its programme of motorship development and use, and, in fact, has actually entered it within the last year. The rate of adoption depends upon the speed with which established facts become recognized and known, and are followed by building orders. It is of considerable interest to note that the motor car industry, in which America now leads the world, developed in Europe in quite the same way as the motorship industry, and it is not too much to expect that once American interests become convinced that the motorship is what the Europeans think it is, American motorship construction and operation will also lead the world."

Annual Meeting of the Institution of Naval Architects

THE annual meeting of the Institution of Naval Architects will be held on March 16, 17 and 18 in the lecture hall of the Royal United Service Institution, Whitehall, W. C. 2, London. An evening reception will be held in the Naval Museum of the Royal United Service Institution on the evening of March 15, and the annual dinner will be held on the evening of March 16 in the Grand Hall, Connaught Rooms, Great Queen Street, Kingsway, W. C.

A gold medal will be awarded by the Council to any person not a member or associate member of the Council, who shall read a paper at the forthcoming meeting which, in the judgment of the Council, is deemed to be of special merit. The Council will also offer a premium of books or instruments to the reader of any paper, not a member or associate member of Council, which in the judgment of the Council merits this distinction.

Test Navy Yard Dry Dock.—The 1,000-foot dry dock at the Philadelphia Navy Yard, known as No. 3, was flooded February 15, as a test, preparatory to being put into commission March 1. There is about 100 feet of earth between the end of the dock, as it now stands, and the Delaware river. This is to be dredged away and the gates connecting the dock with the river will be placed within the next two weeks.

New Motorship *San Miguel*, Built for the Thoreson Line, Christiania

Motorship Building in Europe

BY OUR SPECIAL LONDON CORRESPONDENT

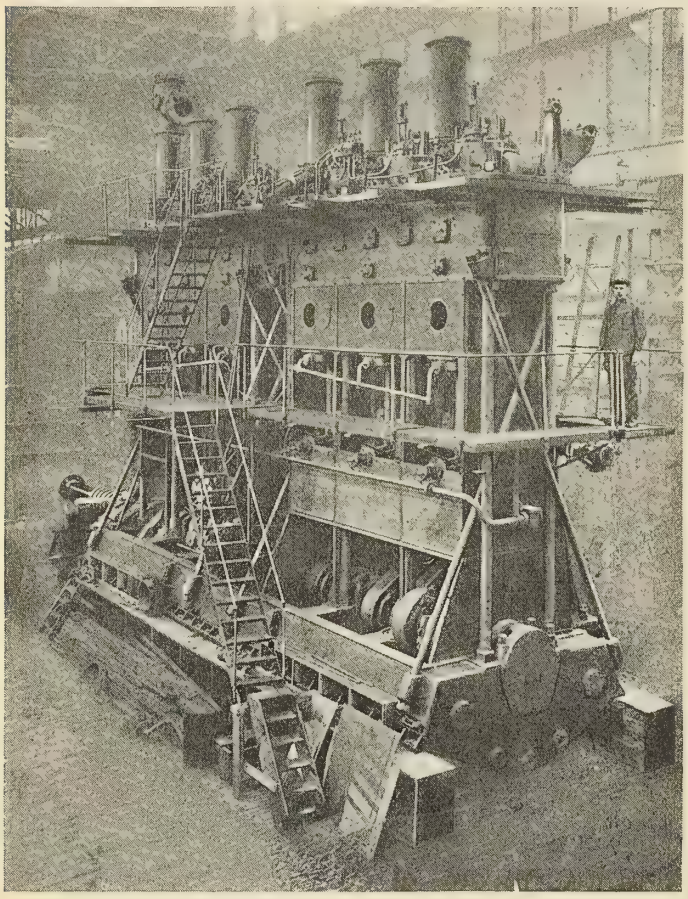
It might be thought that the recent fall in the price of bunker coal in Great Britain would give a setback to the motorship movement. This is not the case, for it is the general opinion of British shipowners that the prices of coal and liquid fuel will move to some extent in unison and that whatever fluctuations take place the Diesel ship will always show a marked saving over the corresponding steamer. Already the price of liquid fuel in English ports has fallen between £2 and £3 per ton, and it must of course be remembered that the respective costs of coal and oil in Europe are no criterion of the relative running expenses of steamships and motorships, since it is always arranged that the latter shall take on fuel at some ports on their route where the price is lowest. This is one of the inestimable advantages of the motorship due to its large radius of action.

MANY interesting motorships have been launched during the past month. Among those which were completed were the *Glenapp,* a notable addition to the already large fleet of motor vessels owned by the Glen Line, while another vessel for the same company, the *Glenbeg,* was launched, making the fourth 500-foot cargo vessel owned by the Glen Line. The *Lobos,* a 10,000-ton freighter, was completed for the Pacific Steam Navigation Company to trade between Glasgow, New York and the west coast of South America through the Panama Canal. She is the second of six motorships for the Pacific Steam Navigation Company, the other four being well under way.

A third vessel recently completed is one of a type rapidly gaining in favor with Scandinavian shipowners, namely, a vessel of about 3,000 tons. She is equipped with two Polar Diesel engines of the two cycle type, each developing 500 horsepower, but it must be admitted that the installation of two engines in such a small vessel is a somewhat costly proceeding. It is now more usual to fit vessels up to 3,000 or 4,000 tons with a single engine, and examples of this policy are given in the recent launches of the motorship *Sevilla* and *Sardinia* on the Tyne and in Holland respectively, both for Norwegian shipowners. The machinery of these two latter ships is worthy of reference. It is of the Werkspoor type, which is now being widely adopted by all classes of shipowners, partly on account of its simplicity and partly because it is probably the cheapest type now constructed. In the first named ship, which only carries about 2,500 tons, a 1,400-horsepower engine is installed, while in the second one of 2,140 horsepower is fitted, a departure from the standard 1,400-horsepower sets, of which probably twenty examples have been built or are approaching completion. It is by this standardization that the Werkspoor Company has been able to bring down the net manufacturing costs, and they are now comparable with those of corresponding steam machinery instead of being at least 25 percent above, which is the normal price for most Diesel plants.

With the development of a 2,140-horsepower engine the Werkspoor Company is now approaching the Burmeister and Wain firm in maximum cylinder output. These new Werkspoor engines are of the six cylinder type, and an eight cylinder motor of the same class would develop approximately

3,000 indicated horsepower against 3,200 indicated horsepower in eight cylinders, which represents the largest engine built to the Burmeister and Wain design. Most engineers on seeing the Werkspoor Diesel engine for the first time are inclined to say that its scantlings are too light for the pressures involved, but experience has shown this view to be incorrect. Unlike any other large marine oil engine, the construction comprises units of three cylinders in one casting, with the liners let into this casting which is supported by vertical steel stanchions of small dimensions. The cylinder covers are then bolted onto the casting and the whole design is thus of the utmost simplicity, while the cylinder cooling arrangements are obviously exceedingly good. No difficulties have been encountered in engines up to 1,400 indicated horse-



A 2,140-Horsepower Werkspoor Four-Cycle Engine Being Erected. This is the Largest of Its Type Yet Built

power, and it will be of the greatest interest to engineers to note the results achieved with the larger motors. The builders' confidence in them is evidenced by their willingness to fit them in single screw ships, where reliability is even of greater importance than it is in twin screw vessels.

The question of the installation of oil engines in liners is now exercising the closest attention of the large European passenger shipowning companies, and although orders for nearly all classes of vessels have now ceased, it is likely that when prices have dropped and contracts are renewed many shipowners will build passenger motor liners. In the meantime, the Italian Transatlantic Company, undeterred by the present slump, has contracted for three motor passenger liners for service between Italy and the United States. These ships, which carry only a small amount of cargo, have accommodation for 350 passengers and present a very unusual appearance, having no funnel. The engine room is arranged amidships, and it is stated that a very large additional space has been rendered available for cabins on account of the difference in the size of Diesel machinery and corresponding steam plant. They will not be high-powered craft, as the machinery consists of two 2,000 brake horsepower Ansaldo Diesel engines (giving a combined indicated horsepower of about 5,500), but it is anticipated that a speed of 13 knots will be attained.

The employment of two cycle Diesel motors for these passenger liners is of some interest in view of the controversy raging regarding the respective advantages of two and four stroke plants. The Ansaldo two cycle engines on the three ships *Ansaldo San Giorgio I, Ansaldo San Giorgio II* and *Ansaldo San Giorgio III* which are now in commission have given exceptionally good service, and the system adopted of controlled port scavenging, which is peculiar to this type of motor, appears to have solved one of the most troublesome problems in two cycle Diesel engine designs. In England the two cycle engine seems to be gaining in favor, and the latest firm to take up Diesel manufacture, the well-known Wallsend Slipway and Engineering Company, decided after careful investigation that the Sulzer two cycle motor offered the greatest possibilities. It is an interesting fact that there are now more firms engaged upon the manufacture of two cycle motors in Great Britain than of the four cycle class.

The three motor passenger liners for the Italian Transatlantic Company will not be the first passenger vessels equipped with oil engines to be completed. This honor will fall to the motorship *Magvana,* which was launched two or three weeks ago on the Clyde for the British India Steam Navigation Company, and which is due for completion early in the spring. She and her two sister vessels now being built are designed to carry 150 passengers, and these are therefore more in the nature of mixed cargo and passenger vessels than pure passenger liners. It may be added that important progress towards the construction of oil engine driven transatlantic liners is anticipated, for the Cunard Company is greatly interested and John Brown & Company, the Clydebank shipbuilders, are now engaged upon the construction of Cammell Laird engines with the ultimate object of their installation in large liners.

Other interesting developments may be expected from some of the more important shipbuilding firms in the very near future, including Scotts Shipbuilding Company, which is manufacturing Still combined steam and oil engines; Armstrong Whitworth & Company, which is building its first Sulzer Diesel engines, and Dunsmuir and Jackson, who are manufacturing Cammellaird-Fullagar sets. So intense is the interest in motor shipbuilding in Great Britain at the present time that it may fairly be said that there is scarcely a shipbuilding firm of any importance which is not very actively engaged in the new industry. The whole trend of feeling is that as soon as the present depression passes there will be such a boom in shipbuilding as even the most optimistic scarcely thought to be possible a year or two back.

British Tonnage Lost During the War.—The Board of Trade, London, has just issued a report regarding the shipping casualties and loss of life occasioned to merchant shipping registered in the United Kingdom, the British Dominions, Colonies, Protectorates, and in India, which occurred in or near the costs of the United Kingdom during the period from July 1, 1914, to December 31, 1918. The number of vessels lost by marine casualty was 915 of a gross tonnage of 1,048,498, while those lost by enemy action amounted to 3,781 with a gross tonnage of 8,363,777, making a total loss of 4,696 vessels of a gross tonnage of 9,412,275. Of the total losses to British registered merchant and fishing vessels during the period of the war 80.52 percent of the number and 88.86 percent of the gross tonnage were losses due to enemy action. The total number of deaths of seamen, fishermen and passengers including prisoners of war is reported as 40,860.

How the Shipping Board Can Economize!

Costs of Fuel and Repairs on Shipping Board Vessels—An Opportunity for Efficiency Experts

BY "OLD SCOTCH"

IN a previous article on the subject of Economy (now a very popular theme with all who are attempting to run ships at existing freight rates and generally depressed business conditions) it was pointed out that the two items of expense where the greatest cuts could be made were in fuel and repairs. This statement was made from general knowledge, without any specific information concerning the relative costs of these important items as incurred in the operation of the Shipping Board's mammoth fleet.

Cost of Operating Shipping Board Vessels

Since that statement was made the Chief of Operations of the Board has appeared before the Walsh committee and summarized the total cost of operations as follows:

Fuel	43 percent
Repairs	30 percent
Wages and overtime	15 percent
Subsistence	4 to 5 percent
Deck and engine stores	6 to 7 percent
Total	100 percent

Of course it will at once be seen that in presenting these percentages of cost of operation, the principal items, namely, depreciation, capital cost and insurance, were neglected, as it is not customary to include them in estimating the expense of operating government-owned vessels. With privately-owned vessels, however, such charges are acutely present and cannot be neglected. It is the custom, based on actual costs, to estimate these three items as 50 percent of the total cost of operating privately-owned ships.

To arrive at the relative expense of maintaining the Board's vessels on a private ship basis, we must, therefore, take the cost of fuel at 21½ percent and the cost of repairs at 15 percent. On the same basis the cost of all wages and overtime will be but 7½ percent, which shows what a small proportion is actually paid to the men comprising the crews of our ships. To the pessimists concerning the ultimate success of our merchant marine, it will be seen that too much stress is placed on the disparity between the wages paid on American ships and those paid to the crews of our rivals. Captain Foley, the Chief of Operations, makes the bold statement that with a proper system of furnishing fuel to American-owned vessels, which he claims can result in saving one-half the cost now paid by our foreign rivals, no further subsidy need be given to our ships to permit them to compete successfully with our rivals. While many experienced ship operators will doubt the accuracy of this statement, and attribute it to ultra optimism, it is certainly worthy of serious consideration, coming from a reliable official, as it does, who has figures to substantiate his statement.

Fuel for the Oil-Burners

On the basis of tonnage, he further states that 80 percent of the government-owned ships are oil burners. We all know that one of the most constructive acts of the Shipping Board has been to locate large fuel oil stations at various ports of the world, where large numbers of American ships call. These stations are supplied with oil by Government tankers, the fuel purchased directly from the producers at the lowest market rates obtainable. The system of distribution is not yet complete, but from experience already gained with the stations in operation, it can quite readily be demonstrated that Captain Foley's claims regarding reductions in the cost are well substantiated.

The Government could and should go a step further in this most praiseworthy undertaking. Although nearly all known oil lands have been taken up from the public domain by private producers, there are still available thousands of acres of public lands containing oil shales. Congress should therefore at once set aside a large area of these lands for the benefit of the merchant marine, to be used when the cost of production of fuel oil from shale equals the cost of fuel oil in its natural state. From the best information obtainable that time is rapidly approaching. Here then we would have the utilization of one of our great natural resources for the benefit of the public at large, through the medium of providing fuel for the American merchant marine.

Economical Use of Fuel

Of almost equal importance to obtaining fuel oil at a low cost is economy in its use aboard ship. Oil-burning ships are comparatively modern, as the system for marine use is practicaly a development of the last decade. American-owned ships have had more experience with this type of fuel than the ships of any other nation, so in this matter at least we are in the vanguard. Oil-burning devices are practically American inventions, as the best of them have been developed and used first in this country. The United States Navy has done much in this development, as our war vessels were the first to adopt this ideal system of steam generation. Hundreds of firemen have been hastily drilled in the art of oil burning to meet the great demands of our rapidly constructed fleet of merchant vessels. To those familiar with the burning of oil as fuel, it is known how readily it can be wasted by carelessness and ignorance on the part of those who manipulate the relative supplies of oil and air to the burners. I think it will not be disputed that at least ten percent of the oil burned on our whole Shipping Board fleet is wasted on account of the lack of skill or carelessness of the men in charge.

Efficiency Experts Needed

The Shipping Board should as soon as possible establish a corps of efficiency experts, and send at least one on each of its operating ships. These men should be carefully selected from young technical graduates, and appointed solely on the basis of their merit and training for the job in hand. Each ship should be furnished with a pyrometer for taking stack temperatures, and with apparatus for analyzing the products of combustion. Five hundred dollars would be ample to supply each ship with all necessary equipment of this kind.

Think of the savings that can be brought about! The estimated cost of oil fuel alone for the Shipping Board fleet for one year is over one hundred million dollars. An investment of say two million dollars for efficiency experts and scientific apparatus will save ten million dollars a year, on a basis of ten percent saving in fuel oil consumed during that period. This is no wild dream, but a very conservative estimate of what can be expected, if this scheme is properly carried out.

I am an old timer myself, and appreciate full well that the tendency of the old-time engineer is to pooh! pooh! any sug-

gestion of this kind. When I first went to sea, if I should have even hinted at such a revolutionary step, I would probably have been clouted over the head with the nearest grate-bar that wasn't working. I can almost hear the howls of "Cut out that highbrow chatter! Wot do them guys know about practical steamboating?"

Ah, my old-time friends, times have changed, and if you haven't kept pace with these scientific developments in burning fuel, you are very soon going to the scrap heap. I have been shown what can be done by the application of these scientific methods, and, after all, science is nothing more nor less than the application of good, ordinary common sense. Let me advise you sea-going boys, young and old, that if any of those "highbrows" should come aboard your ship to show you how to squeeze the most B. T. U.'s out of the oil fuel, don't make the mistake of guying them, if, perhaps, for the first two or three days they get white around the gills from seasickness. Honey up to them and pump them for information as to how they get the "dope" from the machines as to how much CO_2 you are shooting up the stack. Learn all you can from them and put in practice what you learn—it will not only make your own job more secure, but you will be helping to solve the problem of how to keep our Yankee ships on the seas in competition with the "Limies" and the "Japs." They're all good fellows, but no better than you are when you really get down to business.

Current Shipping Board Expenditures Will Influence Merchant Marine Policy

BY WALDON FAWCETT

WHETHER the protracted investigation by a special committee of Congress of the war-time record of the United States Shipping Board and Emergency Fleet Corporation will have any permanent, tangible influence upon the nation's future merchant marine policy is open to doubt. There is, however, a factor in current history in this quarter that is bound to sway Congressional and Governmental sentiment in months and years to come. Muck raking by a group of inquisitors representing the lower house of Congress may serve no better end than to provide a sensation for the newspapers. But the survey made this past few weeks by the Appropriations Committee of the House of Representatives, covering the current and prospective expenditures of the Shipping Board, may be counted upon to find reaction in the policy of the future with respect to the government-owned merchant marine.

The explanation of this contact is not far to seek. It lies in the fact that, henceforth, all phases of United States public policy will be subject in marked degree to considerations of expense. Facing, on the one hand, the requirements of an executive institution the upkeep of which necessitates an annual budget of $4,000,000,000, and, on the other hand, the insistent demands of the public for a reduction of taxes, the national law-making body must essay economy, however unbalanced the effort. We see one manifestation of this impulse to thrift in the agitation in Congress for reduction of naval armaments. A less spectacular but more momentus sequel will come with the trimming of the Federal merchant marine policy to fit the financial cloth.

Prospective Retrenchment

How quickly the menace of prospective retrenchment has been communicated to the shipbuilding centers of the country has been attested by the promptness with which delegations of shipyard workers and business men of shipbuilding communities have appeared at Washington to protest against interruption of the Shipping Board's uncompleted construction programme. While recognizing the need and propriety of the utmost conservatism in governmental expenditures, the spokesmen for the petitioners have urged that it would be a poor economy to halt work abruptly on vessels that are in various stages of completion from 40 percent up, as are those, for example, at the Camden yard of the New York Shipbuilding Corporation.

It was, by the by, in comment upon the submission of a petition signed by 9,000 Delaware River shipyard workers, that the head of the Appropriation's Committee at the Capitol made a statement that gives a broad hint of the Congressional attitude on future governmental participation in the merchant marine. Said Chairman Good: "The Committee has been impressed with the fact that during the war the wages of employees were necessarily increased in order to meet the rapidly increasing cost of living. Perhaps in no single industry were the wages increased more than in the shipbuilding industry, and that was necessary in order to speed up the shipbuilding programme.

Ships Being Constructed at a Loss

"The war is now over and every ship, except the tankers, that the government is getting now and putting into commission means a loss to the government. The tankers are the one exception. Of course, looking at the matter in a broad way, the government does not want to see a man out of employment in the United States who wants to work, if that is possible; at the same time here are contracts, many of which were made on a cost-plus basis or a cost-plus-fee basis, and with industries all over the country reducing wages all the way from 10 to 25 percent, and even a greater percentage, and with quite a substantial reduction being effected in retail prices of clothing and of all food products, it has seemed to the committee that it is only fair that we should do one of two things, we either ought to slow up in this building programme and not crowd it as it has been crowded, because the ships we are getting are operated at a loss, or there ought to be a substantial reduction somewhere in the cost of the government."

Necessity for Wage Reductions

The head of the Appropriation's Committee went on to point out to the assembled shipbuilding representatives and to the group of Congressmen, who are charged with the responsibility of allotting government funds that a huge deficit stares the government in the face. Confronted by an empty treasury, the $95,000,000 asked to be made immediately available to carry on the programme of the Shipping Board appeared, as the chairman put it, "a good deal of money." When it was called to his attention that the rank and file of shipyard workers on the Delaware were amenable to a readjustment of wages, feeling that a reduction was preferable to enforced idleness, he commended their spirit. Unless a policy of wage readjustment be promptly carried out he predicted that by July or August, the shipyards would be

closed and the men out of work, since private interests, no more than the government, could afford to place contracts at prices predicated on the war-time wage scales.

It has been revealed in the discussions at Washington that in shipbuilding districts, such as the Delaware River territory, where the shipyard employees are purchasing the houses in which they reside, the desire to complete payments upon these homes is proving a potent factor in reconciling the men to wage reductions, in lieu of a risk of loss of employment. In order to save their homes, the men are represented as content to conform to any reasonable readjustment of government contracts and likewise to accept wage scales for private contracts that may enable the shipbuilding companies to obtain contracts for private tonnage after the completion of government contracts in the late summer or early autumn. In this same connection, certain well-wishers of the shipbuilding industry are urging that the government should not longer delay the sale to the workers of the dwellings erected under the war-time housing programme, a considerable proportion of which are yet held by the Shipping Board. It is estimated that in the Philadelphia district there is not less than $10,000,000 tied up in houses that might have been sold long ago to the shipyard workers who occupy them. A progressive school of thought that has lately found expression at Washington holds that an effort should be made without further delay to dispose to the occupants all the dwellings erected by the United States Housing Corporation.

Unpaid Bills

The shipbuilding and vessel outfitting interests of the country have, aside from their general interest in the future policy of the government as regards its merchant marine, an immediate concern for the provision of supplementary funds to meet current needs. Scores of firms have past-due claims upon which payment is in arrears; that is to say, there were unpaid, awaiting the appropriation of funds by the 66th Congress, audited vouchers issued by the Division of Construction of the Shipping Board Emergency Fleet Corporation that total more than $14,000,000. Included in this muster of unpaid bills that are past due are items of nearly $2,500,000 due William Cramp & Sons Ship and Engine Building Company, $2,775,000 due the New York Shipbuilding Corporation, nearly half a million dollars due the Baltimore Dry Docks and Shipbuilding Company, and more than that due the Los Angeles Ship Building Company, upward of half a million dollars owing the Newport News Ship Building and Dry Dock Company, and upward of $2,000,000 to the credit of the Bethlehem Shipbuilding Corporation, Ltd.

Money Owing the Shipping Board

Financial embarrassment of the Shipping Board is in part due to the unfortunate aftermath of its ship sale programme. The Board is being required to take back some of the tonnage that it supposed it had sold and a considerable proportion of the amount due for the sale of ships remains unpaid. Indeed, at the opening of the year 1921, the amounts overdue on ship sales aggregated $11,800,000, and the General Comptroller of the Shipping Board, Mr. Alonzo Tweedale, stated that he did not believe that any but a very small proportion of these overdue accounts will be paid. The purchasers of the ships are apparently solvent, he has reported, but by reason of the financial stringency are unable to pay. The situation is further complicated by the fact that some of the deferred notes are due from foreigners and it is provided in the sale agreement that unless the franc falls below 10 to the dollar there are to be granted at least two extensions of these notes. This circumstance has operated to defer payment of a part of the $11,800,000. In the interval between January 1 and June 30, there is due the Shipping Board on the sale of ships an aggregate of $20,000,000, but officials of the Board who have canvassed the situation have stated confidentially that they do not expect to receive more than $10,000,000 of this sum.

A situation but little more encouraging to Shipping Board finances exists with respect to the sum due from the sale of property other than ships, notably salvaged shipbuilding plants and equipment. On surplus salvaged material there is due by June 30 of this year, a total of $13,500,000, but the most optimistic official at the offices of the Shipping Board does not forecast 100 percent collection on these obligations. Payment of 75 percent of the amount due seems to be the measure of the most sanguine expectations. Shipping Board finances have been complicated because of disputes between the Board and the War Department, pending the decision of which the War Department has withheld the payment of millions of dollars claimed to be due for vessels furnished for army transport service. This tangle, which might appear on the surface merely an administrative clash between two branches of the government, has no little interest for private shipbuilding and shipowning interests because many of the items on which payment is in dispute were occasioned by the repair and reconstruction work necessary ere vessels requisitioned for war service could be turned back, in promised condition, to private owners.

Current Costs of Government Ship Operation

Scrutiny of current operations of the Shipping Board precipitated by the demand for a *deficiency* appropriation of upward of $100,000,000, has resulted, to the ultimate enlightenment of maritime circles in illuminating revelations as to current costs of government ship operation. The Board is operating through agencies or through operators a total of more than one thousand ships of which 79 are tankers and the remainder are passenger and cargo ships. From the operation of these ships during the last half of 1920, the Shipping Board received an income of $23,489,000. This was gross and against it were charged operating expenses amounting to $22,300,000 and vessel repairs that footed up about $28,000,000. The falling off in freight rates and the difficulty of obtaining cargoes during the final three months of the year necessitated the taking of a loss in the operation of many of the ships.

In an effort to analyze the situation and ascertain just what conditions are, statisticians of the Shipping Board recently studied the record of operations since September 1 last. Computing the result of representative voyages, on all the various trade routes covered by Shipping Board operations, the investigators arrived at the conclusion that on an average the total loss for the operation of the government owned fleet under the present plan can be set down at $3,800,000 per month. That includes depreciation, maintenance, insurance and all other charges.

It should perhaps be made clear that in seeking the bitter truth the government statisticians did not compute on the full strength of the government-owned merchant fleet. Instead the survey covered 227 vessels. With the basic figures thus obtained worked out on the scale of deadweight tonnage for all the ships on the various trade routes there was calculated the total net loss per month. Shipping Board officials have intimated to Congressmen a belief that the losses of the government in the present dilemma are not out of line with those of private shipowners. It is contended that all private shipowners are to-day losing money in their operations.

Future Policy in Regard to Shipping Board Vessels

When the Appropriation's Committee at the Capitol was acquainted with the full proportions of the loss that the government is sustaining in the operation of the one thousand

(*Continued on page* 250.)

Measurement of Fuel Oil

BY J. D. GILMAN*

The tables given in this article have been compiled by the author for the use of chief engineers and the others interested in arriving at a correct amount of fuel oil that should be charged for by the oil companies when billing for fuel. The standard temperature being 60 degrees Fahrenheit or 15.6 degrees Centigrade, all fuel oil should be reduced to its volume at this temperature.

FUEL oil used for firing boilers is measured on the West coast of the United States by the 42-gallon barrel containing 9,702 cubic inches or 5.6145 cubic feet. In other parts of the world the long ton of 2,240 pounds is used. In English ports the long ton of 2,240 pounds, with the subdivisions of the hundredweight of 112 pounds, the quarter of 28 pounds and the pound, is usually used.

In buying and using fuel oil the usual standard is 60 degrees Fahrenheit or 15.6 degrees Centigrade, and the amount is corrected to what it would be at this standard temperature to arrive at the exact amount.

Where the barrel is used as the measure, only one correction is necessary, that of the expansion, and as the ordinary fuel expands about .0004 in volume for each degree Fahrenheit and about .00703 for each degree Centigrade, the corrected amount can readily be found by the use of Table I, where the temperature is taken in Fahrenheit degrees, and Table II, where the temperature is taken in Centigrade degrees. The figures given in these tables are multipliers, and if the amount of oil under consideration is multiplied by the decimal shown opposite its temperature, the product will be the net amount of oil at the standard temperature. This is the correct amount that should be charged.

Where the ton of 2,240 pounds is used as the measure to arrive at the correct amount, additional calculations are necessary. It is usual, and should be demanded, that the cubic feet, degrees Baume or specific gravity, and the temperature be furnished, so that a check can be made of the amount charged. Having the cubic feet and temperature, the volume at the standard 60 degrees Fahrenheit or 15.6 degrees Centigrade can easily be found by Table I or Table II, depending upon which thermometer is used.

The specific gravity of the oil also changes with the temperature, and Table III gives a correction factor that must be added to the observed specific gravity, if the temperature is above the standard, and subtracted if the temperature is below the standard; when this is done the correct specific gravity will be found, to use in finding the weight of the oil under consideration.

Having the corrected volume of the oil and the cor-

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TABLE I.—Temperature Correction Table for Fahrenheit Thermometer.

Degrees F	Net-Gross Multiplied By	Degrees F	Net-Gross Multiplied By	Degrees F	Net-Gross Multiplied By	Degrees F	Net-Gross Multiplied By	Degrees F	Net-Gross Multiplied By
40	1.00806	75	.994036	110	.980392	145	.967118	180	.954198
41	1.00766	76	.993641	111	.980008	146	.966744	181	.953834
42	1.00725	77	.993246	112	.979624	147	.966370	182	.953471
43	1.00685	78	.992851	113	.979240	148	.965997	183	.953107
44	1.00644	79	.992457	114	.978857	149	.965624	184	.952744
45	1.00604	80	.992063	115	.978474	150	.965251	185	.952381
46	1.00563	81	.991670	116	.978091	151	.964878	186	.952018
47	1.00523	82	.991277	117	.977708	152	.9 4506	187	.951656
48	1.00482	83	.990884	118	.977326	153	.964134	188	.951294
49	1.00442	84	.990491	119	.976944	154	.963763	189	.950932
50	1.00402	85	.990099	120	.976563	155	.963391	190	.950570
51	1.00361	86	.989707	121	.976181	156	.963020	191	.950209
52	1.00321	87	.989315	122	.975800	157	.962649	192	.949848
53	1.00281	88	.988924	123	.975419	158	.962279	193	.949487
54	1.00241	89	.988533	124	.975039	159	.961908	194	.949127
55	1.00200	90	.988142	125	.974659	160	.961538	195	.948767
56	1.00160	91	.987752	126	.974279	161	.961169	196	.948407
57	1.00120	92	.987362	127	.973900	162	.960799	197	.948047
58	1.00080	93	.986972	128	.973520	163	.960430	198	.947688
59	1.00040	94	.986582	129	.973141	164	.960061	199	.947329
60	1.00000	95	.986193	130	.972763	165	.959693		
61	.999600	96	.985804	131	.972384	166	.959325		
62	.999201	97	.985416	132	.972006	167	.958957		
63	.998801	98	.985028	133	.971628	168	.958589		
64	.998403	99	.984640	134	.971251	169	.958222		
65	.998004	100	.984252	135	.970874	170	.957854		
66	.997606	101	.983865	136	.970497	171	.957488		
67	.997208	102	.983478	137	.970120	172	.957121		
68	.996810	103	.983091	138	.969744	173	.956755		
69	.996413	104	.982704	139	.969368	174	.956389		
70	.996016	105	.982318	140	.968992	175	.956023		
71	.995619	106	.981932	141	.968617	176	.955658		
72	.995223	107	.981547	142	.968242	177	.955292		
73	.994827	108	.981162	143	.967867	178	.954927		
74	.994431	109	.980777	144	.967492	179	.954563		

TABLE II.—TEMPERATURE CORRECTION TABLE FOR CENTRIGRADE THERMOMETER.

Degrees C.	Net-Gross Multiplied By	Degrees C.	Net-Gross Multiplied By	Degrees C.	Net-Gross Multiplied By
5	1.0076600	35	.9861930	65½	.96528950
5½	1.0072960	35½	.9858441	66	.96495500
6	1.0069320	36	.9854952	66½	.96462050
6½	1.0065680	36½	.9851463	67	.96428600
7	1.0062040	37	.9847974	67½	.96395150
7½	1.0058400	37½	.9844485	68	.96361700
8	1.0054760	38	.9840996	68½	.96328250
8½	1.0051120	38½	.9837507	69	.96294800
9	1.0047480	39	.9834018	69½	.96261350
9½	1.0043840	39½	.9830529	70	.96227900
10	1.0040200	40	.9827040	70½	.96194680
10½	1.0036580	40½	.9823576	71	.96161460
11	1.0032960	41	.9820112	71½	.96128240
11½	1.0029340	41½	.9816648	72	.96095020
12	1.0025720	42	.9813184	72½	.96061800
12½	1.0022100	42½	.9809720	73	.96028580
13	1.0018480	43	.9806256	73½	.95995360
13½	1.0014860	43½	.9802792	74	.95962140
14	1.0011240	44	.9799328	74½	.95928920
14½	1.0007620	44½	.9795864	75	.95895700
15	1.0004000	45	.9792400	75½	.95862710
15½	1.0000410	45½	.9788960	76	.95829720
15.6	1.0000000	46	.9785520	76½	.95796730
16	.9996820	46½	.9782080	77	.95763740
16½	.9993230	47	.9778640	77½	.95730750
17	.9989640	47½	.9775200	78	.95697760
17½	.9986050	48	.9771760	78½	.95664770
18	.9982460	48½	.9768320	79	.95631780
18½	.9978870	49	.9764880	79½	.95598790
19	.9975280	49½	.9761440	80	.95565800
19½	.9971690	50	.9758000	80½	.95533030
20	.9968100	50½	.9754584	81	.95500260
20½	.9964536	51	.9751168	81½	.95467490
21	.9960972	51½	.9747752	82	.95434720
21½	.9957408	52	.9744336	82½	.95401950
22	.9953844	52½	.9740920	83	.95369180
22½	.9950280	53	.9737504	83½	.95336410
23	.9946716	53½	.9734088	84	.95303640
23½	.9943152	54	.9730672	84½	.95270870
24	.9939588	54½	.9727256	85	.95238100
24½	.9936024	55	.9723840	85½	.95205560
25	.9932460	55½	.9720448	86	.95173020
25½	.9928921	56	.9717056	86½	.95140480
26	.9925382	56½	.9713664	87	.95107940
26½	.9921843	57	.9710272	87½	.95075400
27	.9918304	57½	.9706880	88	.95042860
27½	.9914765	58	.9703488	88½	.95010320
28	.9911226	58½	.9700096	89	.94977780
28½	.9907687	59	.9696704	89½	.94945240
29	.9904148	59½	.9693312	90	.94912700
29½	.9900609	60	.9689920	90½	.94880380
30	.9897070	60½	.9686552	91	.94848060
30½	.9893556	61	.9683184	91½	.94815740
31	.9890042	61½	.9679816	92	.94783420
31½	.9886528	62	.9676448	92½	.94751100
32	.9883014	62½	.9673080	93	.94718780
32½	.9879500	63	.9669712	93½	.94686460
33	.9875986	63½	.9666344	94	.94654140
33½	.9872472	64	.9662976	94½	.94621820
34	.9868958	54½	.9659608	95	.94589500
34½	.9865444	65	.9656240		

TABLE III—OBSERVED SPECIFIC GRAVITY.

Observed Temp. C.	0.650	0.700	0.750	0.800	0.850	0.860	0.870	0.880	0.890	0.900	0.910	0.920	0.930	0.940	0.950	0.960
	Subtract From Observed Specific Gravity.															
1.	.01596	.01490	.01383	.01280	.01170	.01140	.01120	.01100	.01080	.01064	.01064	.01064	.01064	.01064	.01064	.01064
.5	.01550	.01440	.01346	.01240	.01135	.01110	.01090	.01070	.01050	.01032	.01032	.01032	.01032	.01032	.01032	.01032
0.	.01500	.01400	.01300	.01200	.01100	.01080	.01060	.01040	.01020	.01000	.01000	.01000	.01000	.01000	.01000	.01000
.5	.01450	.01360	.01250	.01160	.01065	.01050	.01030	.01010	.00990	.00970	.00970	.00970	.00970	.00970	.00970	.00970
1.	.01400	.01310	.01220	.01120	.01030	.01020	.01000	.00980	.00960	.00940	.00940	.00940	.00940	.00940	.00940	.00940
1.5	.01350	.01260	.01170	.01080	.00990	.00970	.00950	.00930	.00910	.00900	.00900	.00900	.00900	.00900	.00900	.00900
2	.01300	.01220	.01130	.01040	.00960	.00950	.00920	.00910	.00890	.00870	.00870	.00870	.00870	.00870	.00870	.00870
2.5	.01260	.01170	.01090	.01000	.00920	.00900	.00880	.00860	.00850	.00840	.00840	.00840	.00840	.00840	.00840	.00840
3.	.01210	.01130	.01050	.00970	.00890	.00870	.00850	.00840	.00820	.00800	.00800	.00800	.00800	.00800	.00800	.00800
3.5	.01160	.01090	.01010	.00930	.00850	.00830	.00820	.00810	.00790	.00770	.00770	.00770	.00770	.00770	.00770	.00770
4.	.01120	.01050	.00960	.00890	.00820	.00800	.00780	.00770	.00760	.00740	.00740	.00740	.00740	.00740	.00740	.00740
4.5	.01070	.01000	.00920	.00850	.00780	.00760	.00740	.00730	.00720	.00710	.00710	.00710	.00710	.00710	.00710	.00710
5.	.01020	.00950	.00880	.00810	.00750	.00730	.00710	.00700	.00690	.00680	.00680	.00680	.00680	.00680	.00680	.00680
5.5	.00970	.00910	.00830	.00770	.00720	.00710	.00690	.00670	.00660	.00650	.00650	.00650	.00650	.00650	.00650	.00650
6.	.00920	.00860	.00800	.00740	.00680	.00670	.00650	.00630	.00620	.00610	.00610	.00610	.00610	.00610	.00610	.00610
6.5	.00870	.00820	.00760	.00700	.00640	.00630	.00610	.00600	.00590	.00580	.00580	.00580	.00580	.00580	.00580	.00580
7.	.00830	.00770	.00720	.00660	.00610	.00600	.00590	.00580	.00570	.00550	.00550	.00550	.00550	.00550	.00550	.00550
7.5	.00780	.00730	.00670	.00620	.00570	.00560	.00550	.00540	.00530	.00520	.00520	.00520	.00520	.00520	.00520	.00520
8.	.00730	.00680	.00630	.00580	.00540	.00530	.00520	.00510	.00500	.00480	.00480	.00480	.00480	.00480	.00480	.00480
8.5	.00680	.00640	.00590	.00540	.00500	.00490	.00480	.00470	.00460	.00450	.00450	.00450	.00450	.00450	.00450	.00450
9	.00630	.00590	.00550	.00500	.00470	.00460	.00450	.00440	.00430	.00420	.00420	.00420	.00420	.00420	.00420	.00420
9.5	.00590	.00550	.00500	.00470	.00430	.00430	.00420	.00410	.00400	.00390	.00390	.00390	.00390	.00390	.00390	.00390
10	.00540	.00500	.00460	.00430	.00400	.00400	.00390	.00380	.00370	.00360	.00360	.00360	.00360	.00360	.00360	.00360
10.5	.00490	.00450	.00420	.00390	.00370	.00370	.00360	.00350	.00340	.00330	.00330	.00330	.00330	.00330	.00330	.00330
11	.00440	.00410	.00380	.00350	.00330	.00330	.00320	.00310	.00310	.00300	.00300	.00300	.00300	.00300	.00300	.00300
11.5	.00390	.00370	.00340	.00310	.00290	.00280	.00280	.00270	.00270	.00260	.00260	.00260	.00260	.00260	.00260	.00260
12.	.00340	.00320	.00300	.00270	.00250	.00250	.00250	.00240	.00240	.00230	.00230	.00230	.00230	.00230	.00230	.00230
12.5	.00300	.00280	.00260	.00240	.00220	.00220	.00220	.00210	.00210	.00200	.00200	.00200	.00200	.00200	.00200	.00200
13.	.00250	.00230	.00220	.00200	.00180	.00180	.00180	.00170	.00170	.00170	.00170	.00170	.00170	.00170	.00170	.00170
13.5	.00200	.00190	.00170	.00160	.00150	.00150	.00150	.00140	.00140	.00130	.00130	.00130	.00130	.00130	.00130	.00130
14.	.00150	.00140	.00130	.00120	.00110	.00110	.00110	.00100	.00100	.00100	.00100	.00100	.00100	.00100	.00100	.00100
14.5	.00100	.00090	.00090	.00080	.00080	.00080	.00080	.00070	.00070	.00064	.00064	.00064	.00064	.00064	.00064	.00064
15.	.00060	.00050	.00050	.00046	.00040	.00040	.00040	.00040	.00040	.00038	.00038	.00038	.00038	.00038	.00038	.00038
15.6	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
	ADD TO OBSERVED SPECIFIC GRAVITY TO GIVE TRUE SPECIFIC GRAVITY AT 60°/60° F or 15.6° C.															
16.	.00036	.00032	.00030	.00028	.00025	.00025	.00025	.00024	.00024	.00024	.00024	.00024	.00024	.00024	.00024	.00024
16.5	.00080	.00070	.00060	.00060	.00050	.00050	.00050	.00050	.00050	.00050	.00050	.00050	.00050	.00050	.00050	.00050
17.	.00120	.00110	.00100	.00090	.00080	.00080	.00080	.00080	.00080	.00080	.00080	.00080	.00080	.00080	.00080	.00080
17.5	.00160	.00150	.00140	.00130	.00120	.00120	.00120	.00110	.00110	.00110	.00110	.00110	.00110	.00110	.00110	.00110
18.	.00210	.00190	.00180	.00160	.00150	.00150	.00150	.00140	.00140	.00140	.00140	.00140	.00140	.00140	.00140	.00140
18.5	.00260	.00230	.00210	.00200	.00180	.00180	.00180	.00170	.00170	.00170	.00170	.00170	.00170	.00170	.00170	.00170
19.	.00310	.00270	.00250	.00230	.00210	.00210	.00210	.00200	.00200	.00200	.00200	.00200	.00200	.00200	.00200	.00200
19.5	.00350	.00310	.00290	.00270	.00250	.00250	.00250	.00240	.00240	.00240	.00240	.00240	.00240	.00240	.00240	.00240
20.	.00400	.00350	.00330	.00300	.00270	.00270	.00270	.00270	.00270	.00270	.00270	.00270	.00270	.00270	.00270	.00270
20.5	.00440	.00390	.00360	.00340	.00300	.00300	.00300	.00300	.00300	.00300	.00300	.00300	.00300	.00300	.00300	.00300
21.	.00480	.00430	.00400	.00370	.00330	.00330	.00330	.00330	.00330	.00330	.00330	.00330	.00330	.00330	.00330	.00330
21.5	.00530	.00470	.00440	.00410	.00370	.00370	.00370	.00360	.00360	.00360	.00360	.00360	.00360	.00360	.00360	.00360
22.	.00570	.00510	.00480	.00440	.00400	.00400	.00400	.00390	.00390	.00390	.00390	.00390	.00390	.00390	.00390	.00390
22.5	.00610	.00550	.00510	.00480	.00430	.00430	.00430	.00420	.00420	.00420	.00420	.00420	.00420	.00420	.00420	.00420
23.	.00660	.00590	.00550	.00510	.00460	.00460	.00460	.00450	.00450	.00450	.00450	.00450	.00450	.00450	.00450	.00450
23.5	.00710	.00630	.00590	.00550	.00490	.00490	.00490	.00480	.00480	.00480	.00480	.00480	.00480	.00480	.00480	.00480
24.	.00750	.00670	.00630	.00580	.00520	.00520	.00520	.00510	.00510	.00510	.00510	.00510	.00510	.00510	.00510	.00510
24.5	.00800	.00710	.00660	.00620	.00550	.00550	.00550	.00540	.00540	.00540	.00540	.00540	.00540	.00540	.00540	.00540
25.	.00840	.00750	.00700	.00650	.00580	.00580	.00580	.00570	.00570	.00570	.00570	.00570	.00570	.00570	.00570	.00570
25.5	.00890	.00790	.00740	.00690	.00610	.00610	.00610	.00600	.00600	.00600	.00600	.00600	.00600	.00600	.00600	.00600
26.	.00930	.00830	.00780	.00720	.00650	.00650	.00640	.00640	.00630	.00630	.00630	.00630	.00630	.00630	.00630	.00630
26.5	.00980	.00870	.00810	.00760	.00680	.00680	.00670	.00670	.00660	.00660	.00660	.00660	.00660	.00660	.00660	.00660
27.	.01020	.00910	.00850	.00790	.00710	.00710	.00700	.00700	.00690	.00690	.00690	.00690	.00690	.00690	.00690	.00690
27.5	.01070	.00950	.00890	.00830	.00740	.00740	.00740	.00730	.00730	.00730	.00730	.00730	.00730	.00730	.00730	.00730
28.	.01110	.01000	.00930	.00860	.00770	.00770	.00770	.00760	.00760	.00760	.00760	.00760	.00760	.00760	.00760	.00760
28.5	.01160	.01030	.00960	.00900	.00800	.00800	.00800	.00790	.00790	.00790	.00790	.00790	.00790	.00790	.00790	.00790
29.	.01200	.01070	.01000	.00930	.00830	.00830	.00830	.00820	.00820	.00820	.00820	.00820	.00820	.00820	.00820	.00820
29.5	.01250	.01110	.01040	.00970	.00870	.00870	.00860	.00860	.00850	.00850	.00850	.00850	.00850	.00850	.00850	.00850
30.	.01300	.01160	.01080	.01000	.00900	.00900	.00890	.00890	.00880	.00880	.00880	.00880	.00880	.00880	.00880	.00880
30.5	.01340	.01200	.01110	.01040	.00930	.00930	.00920	.00920	.00910	.00910	.00910	.00910	.00910	.00910	.00910	.00910
31.	.01380	.01240	.01150	.01070	.00960	.00960	.00950	.00950	.00940	.00940	.00940	.00940	.00940	.00940	.00940	.00940
31.5	.01430	.01280	.01190	.01110	.00990	.00990	.00980	.00980	.00970	.00970	.00970	.00970	.00970	.00970	.00970	.00970
32.	.01470	.01320	.01230	.01140	.01020	.01020	.01010	.01010	.01000	.01000	.01000	.01000	.01000	.01000	.01000	.01000
32.5	.01520	.01360	.01260	.01180	.01050	.01050	.01040	.01040	.01030	.01030	.01030	.01030	.01030	.01030	.01030	.01030
33	.01560	.01400	.01300	.01210	.01080	.01080	.01070	.01070	.01060	.01060	.01060	.01060	.01060	.01060	.01060	.01060
33.5	.01610	.01440	.01340	.01250	.01110	.01110	.01170	.01100	.01090	.01090	.01090	.01090	.01090	.01090	.01090	.01090
34.	.01650	.01480	.01380	.01280	.01150	.01140	.01100	.01130	.01120	.01120	.01120	.01120	.01120	.01120	.01120	.01120
34.5	.01700	.01520	.01410	.01320	.01180	.01170	.01160	.01160	.01150	.01150	.01150	.01150	.01150	.01150	.01150	.01150
35.	.01740	.01560	.01450	.01350	.01210	.01200	.01190	.01190	.01180	.01180	.01180	.01180	.01180	.01180	.01180	.01180
35.5	.01790	.01600	.01490	.01390	.01240	.01230	.01220	.01220	.01210	.01210	.01210	.01210	.01210	.01210	.01210	.01210
36.	.01830	.01640	.01530	.01420	.01270	.01260	.01250	.01250	.01240	.01240	.01240	.01240	.01240	.01240	.01240	.01240
36.5	.01880	.01680	.01560	.01460	.01300	.01300	.01290	.01290	.01280	.01280	.01280	.01280	.01280	.01280	.01280	.01280
37.	.01920	.01720	.01600	.01490	.01330	.01330	.01320	.01320	.01310	.01310	.01310	.01310	.01310	.01310	.01310	.01310
37.5	.01970	.01760	.01640	.01530	.01370	.01360	.01350	.01350	.01340	.01340	.01340	.01340	.01340	.01340	.01340	.01340
38.	.02010	.01800	.01680	.01560	.01400	.01390	.01380	.01380	.01370	.01370	.01370	.01370	.01370	.01370	.01370	.01370
38.5	.02060	.01840	.01710	.01600	.01430	.01420	.01410	.01410	.01400	.01400	.01400	.01400	.01400	.01400	.01400	.01400
39.	.02100	.01880	.01750	.01630	.01460	.01450	.01440	.01440	.01430	.01430	.01430	.01430	.01430	.01430	.01430	.01430
39.5	.02150	.01920	.01790	.01670	.01490	.01480	.01470	.01470	.01460	.01460	.01460	.01460	.01460	.01460	.01460	.01460
40.	.02200	.01960	.01830	.01700	.01520	.01510	.01500	.01500	.01490	.01490	.01490	.01490	.01490	.01490	.01490	.01490
40.5	.02240	.02000	.01870	.01740	.01550	.01540	.01530	.01530	.01520	.01520	.01520	.01520	.01520	.01520	.01520	.01520
41.	.02280	.02040	.01900	.01770	.01580	.01570	.01560	.01560	.01550	.01550	.01550	.01550	.01550	.01550	.01550	.01550
41.5	.02330	.02080	.01940	.01810	.01620	.01610	.01600	.01590	.01580	.01580	.01580	.01580	.01580	.01580	.01580	.01580
42.	.02370	.02120	.01980	.01840	.01650	.01640	.01630	.01620	.01610	.01610	.01610	.01610	.01610	.01610	.01610	.01610
42.5	.02420	.02160	.02020	.01880	.01680	.01670	.01660	.01650	.01640	.01640	.01640	.01640	.01640	.01640	.01640	.01640
43.	.02460	.02200	.02050	.01910	.01710	.01700	.01690	.01680	.01680	.01670	.01670	.01670	.01670	.01670	.01670	.01670
43.5	.02510	.02240	.02090	.01950	.01740	.01730	.01720	.01710	.01700	.01700	.01700	.01700	.01700	.01700	.01700	.01700
44.	.02550	.02280	.02130	.01980	.01770	.01760	.01750	.01740	.01730	.01730	.01730	.01730	.01730	.01730	.01730	.01730
44.5	.02600	.02320	.02170	.02020	.01800	.01790	.01780	.01780	.01770	.01770	.01770	.01770	.01770	.01770	.01770	.01770
45.	.02640	.02360	.02200	.02050	.01830	.01820	.01810	.01810	.01800	.01800	.01800	.01800	.01800	.01800	.01800	.01800
45.5	.02690	.02400	.02240	.02090	.01870	.01860	.01850	.01840	.01830	.01830	.01830	.01830	.01830	.01830	.01830	.01830
46.	.02730	.02440	.02280	.02120	.01900	.01890	.01880	.01870	.01860	.01860	.01860	.01860	.01860	.01860	.01860	.01860
46.5	.02780	.02480	.02320	.02160	.01930	.01920	.01910	.01900	.01890	.01890	.01890	.01890	.01890	.01890	.01890	.01890
47.	.02820	.02520	.02350	.02190	.01960	.01950	.01940	.01930	.01920	.01920	.01920	.01920	.01920	.01920	.01920	.01920
47.5	.02870	.02560	.02390	.02230	.01990	.01980	.01970	.01960	.01950	.01950	.01950	.01950	.01950	.01950	.01950	.01950
48.	.02910	.02600	.02430	.02260	.02020	.02010	.02000	.01990	.01980	.01980	.01980	.01980	.01980	.01980	.01980	.01980
48.5	.02960	.02640	.02460	.02300	.02050	.02040	.02030	.02020	.02010	.02010	.02010	.02010	.02010	.02010	.02010	.02010
49.	.03000	.02680	.02500	.02330	.02080	.02070	.02060	.02050	.02040	.02040	.02040	.02040	.02040	.02040	.02040	.02040
49.5	.03050	.02730	.02540	.02370	.02120	.02110	.02100	.02090	.02080	.02070	.02070	.02070	.02070	.02070	.02070	.02070
50.0	.03090	.02770	.02580	.02400	.02150	.02140	.02130	.02120	.02110	.02100	.02100	.02100	.02100	.02100	.02100	.02100

TABLE III (Cont.)—OBSERVED SPECIFIC GRAVITY.

Observed Temp. C.	0.65000	0.70000	0.75000	0.80000	0.85000	0.86000	0.87000	0.88000	0.89000	0.90000	0.91000	0.9200	0.93000	0.94000	0.95000	0.96000
	ADD TO OBSERVED SPECIFIC GRAVITY TO GIVE TRUE SPECIFIC GRAVITY AT 60°/60° F. or 15.6° C.															
50.5	.03140	.02810	.02620	.02440	.02180	.02170	.02160	.02150	.02140	.02130	.02130	.02130	.02130	.02130	.02130	.02130
51.	.03180	.02850	.02650	.02470	.02210	.02200	.02190	.02180	.02170	.02160	.02160	.02160	.02160	.02160	.02160	.02160
51.5	.03230	.02890	.02690	.02510	.02240	.02230	.02220	.02210	.02200	.02190	.02190	.02190	.02190	.02190	.02190	.02190
52.	.03270	.02930	.02730	.02540	.02270	.02260	.02250	.02240	.02230	.02220	.02220	.02220	.02220	.02220	.02220	.02220
52.5	.03320	.02970	.02770	.02580	.02300	.02290	.02280	.02270	.02260	.02260	.02260	.02260	.02260	.02260	.02260	.02260
53.	.03360	.03010	.02800	.02610	.02340	.02330	.02320	.02310	.02300	.02290	.02290	.02290	.02290	.02290	.02290	.02290
53.5	.03410	.03050	.02840	.02650	.02370	.02360	.02350	.02340	.02330	.02320	.02320	.02320	.02320	.02320	.02320	.02320
54.	.03450	.03090	.02880	.02680	.02400	.02390	.02380	.02370	.02360	.02350	.02350	.02350	.02350	.02350	.02350	.02350
54.5	.03500	.03130	.02920	.02720	.02430	.02420	.02410	.02400	.02390	.02380	.02380	.02380	.02380	.02380	.02380	.02380
55.	.03540	.03170	.02950	.02750	.02460	.02450	.02440	.02430	.02420	.02410	.02410	.02410	.02410	.02410	.02410	.02410
55.5	.03590	.03210	.02990	.02790	.02490	.02480	.02470	.02460	.02450	.02440	.02440	.02440	.02440	.02440	.02440	.02440
56.	.03630	.03250	.03030	.02820	.02520	.02510	.02500	.02490	.02480	.02470	.02470	.02470	.02470	.02470	.02470	.02470
56.5	.03680	.03290	.03070	.02860	.02550	.02540	.02530	.02520	.02510	.02500	.02500	.02500	.02500	.02500	.02500	.02500
57.	.03720	.03330	.03100	.02890	.02580	.02570	.02560	.02550	.02540	.02530	.02530	.02530	.02530	.02530	.02530	.02530
57.5	.03770	.03370	.03140	.02930	.02610	.02600	.02590	.02580	.02570	.02560	.02560	.02560	.02560	.02560	.02560	.02560
58.	.03810	.03410	.03180	.02960	.02650	.02630	.02620	.02610	.02600	.02590	.02590	.02590	.02590	.02590	.02590	.02590
58.5	.03860	.03450	.03210	.03000	.02680	.02660	.02650	.02640	.02630	.02620	.02620	.02620	.02620	.02620	.02620	.02620
59.	.03900	.03490	.03250	.03030	.02710	.02690	.02680	.02670	.02660	.02650	.02650	.02650	.02650	.02650	.02650	.02650
59.5	.03950	.03530	.03290	.03070	.02740	.02720	.02710	.02700	.02690	.02680	.02680	.02680	.02680	.02680	.02680	.02680
60.	.04000	.03570	.03330	.03100	.02780	.02760	.02740	.02730	.02720	.02710	.02710	.02710	.02710	.02710	.02710	.02710
60.5	.04040	.03610	.03360	.03140	.02800	.02790	.02780	.02760	.02750	.02740	.02740	.02740	.02740	.02740	.02740	.02740
61.	.04080	.03650	.03400	.03170	.02830	.02810	.02790	.02770	.02760	.02770	.02770	.02770	.02770	.02770	.02770	.02770
61.5	.04130	.03690	.03440	.03210	.02860	.02840	.02820	.02810	.02800	.02810	.02810	.02810	.02810	.02810	.02810	.02810
62.	.04170	.03730	.03480	.03240	.02900	.02880	.02870	.02860	.02850	.02840	.02840	.02840	.02840	.02840	.02840	.02840
62.5	.04220	.03770	.03520	.03280	.02930	.02910	.02900	.02890	.02880	.02870	.02870	.02870	.02870	.02870	.02870	.02870
63.	.04260	.03810	.03550	.03310	.02960	.02940	.02930	.02920	.02910	.02900	.02900	.02900	.02900	.02900	.02900	.02900
63.5	.04310	.03850	.03590	.03340	.02990	.02970	.02960	.02950	.02940	.02930	.02930	.02930	.02930	.02930	.02930	.02930
64.	.04350	.03890	.03630	.03380	.03020	.03000	.02990	.02980	.02970	.02960	.02960	.02960	.02960	.02960	.02960	.02960
64.5	.04400	.03936	.03660	.03420	.03050	.03030	.03020	.03010	.03000	.02990	.02990	.02990	.02990	.02990	.02990	.02990
65.	.04440	.03970	.03700	.03450	.03080	.03070	.03050	.03040	.03030	.03020	.03020	.03020	.03020	.03020	.03020	.03020
65.5	.04490	.04010	.03740	.03490	.03110	.03090	.03080	.03070	.03060	.03050	.03050	.03050	.03050	.03050	.03050	.03050
66.	.04530	.04050	.03780	.03520	.03150	.03130	.03110	.03100	.03090	.03080	.03080	.03080	.03080	.03080	.03080	.03080
66.5	.04580	.04090	.03820	.03560	.03180	.03160	.03140	.03130	.03120	.03110	.03110	.03110	.03110	.03110	.03110	.03110
67.	.04620	.04130	.03850	.03590	.03210	.03190	.03170	.03160	.03150	.03140	.03140	.03140	.03140	.03140	.03140	.03140
67.5	.04670	.04170	.03890	.03630	.03240	.03220	.03200	.03190	.03180	.03170	.03170	.03170	.03170	.03170	.03170	.03170
68.	.04710	.04210	.03930	.03660	.03270	.03250	.03230	.03220	.03210	.03200	.03200	.03200	.03200	.03200	.03200	.03200
68.5	.04750	.04250	.03960	.03700	.03300	.03280	.03260	.03250	.03240	.03230	.03230	.03230	.03230	.03230	.03230	.03230
69.	.04800	.04300	.04000	.03730	.03330	.03310	.03290	.03280	.03270	.03260	.03260	.03260	.03260	.03260	.03260	.03260
69.5	.04850	.04340	.04040	.03770	.03370	.03350	.03330	.03320	.03310	.03300	.03300	.03300	.03300	.03300	.03300	.03300
70.	.04900	.04380	.04080	.03800	.03400	.03380	.03360	.03350	.03340	.03330	.03330	.03330	.03330	.03330	.03330	.03330
70.5	.04940	.04420	.04110	.03840	.03430	.03410	.03390	.03380	.03370	.03360	.03360	.03360	.03360	.03360	.03360	.03360
71.	.04980	.04460	.04150	.03870	.03460	.03440	.03420	.03410	.03400	.03390	.03390	.03390	.03390	.03390	.03390	.03390
71.5	.05030	.04500	.04190	.03910	.03500	.03480	.03460	.03440	.03430	.03420	.03420	.03420	.03420	.03420	.03420	.03420
72.	.05070	.04540	.04230	.03940	.03520	.03500	.03480	.03470	.03460	.03450	.03450	.03450	.03450	.03450	.03450	.03450
72.5	.05120	.04580	.04260	.03980	.03540	.03520	.03510	.03500	.03490	.03480	.03480	.03480	.03480	.03480	.03480	.03480
73.	.05160	.04620	.04300	.04010	.03580	.03560	.03540	.03530	.03520	.03510	.03510	.03510	.03510	.03510	.03510	.03510
73.5	.05210	.04660	.04340	.04050	.03610	.03590	.03570	.03560	.03550	.03540	.03540	.03540	.03540	.03540	.03540	.03540
74.	.05250	.04700	.04380	.04080	.03650	.03630	.03610	.03590	.03580	.03570	.03570	.03570	.03570	.03570	.03570	.03570
74.5	.05300	.04740	.04410	.04120	.03680	.03660	.03640	.03620	.03610	.03600	.03600	.03600	.03600	.03600	.03600	.03600
75.	.05340	.04780	.04450	.04150	.03710	.03690	.03670	.03650	.03640	.03630	.03630	.03630	.03630	.03630	.03630	.03630
75.5	.05390	.04820	.04490	.04190	.03740	.03720	.03700	.03680	.03670	.03660	.03660	.03660	.03660	.03660	.03660	.03660
76.	.05430	.04860	.04530	.04220	.03770	.03750	.03730	.03710	.03700	.03690	.03690	.03690	.03690	.03690	.03690	.03690
76.5	.05480	.04900	.04560	.04260	.03800	.03780	.03760	.03740	.03730	.03720	.03720	.02720	.03720	.03720	.03720	.03720
77.	.05520	.04940	.04600	.04290	.03830	.03810	.03790	.03770	.03760	.03750	.03750	.03750	.03750	.03750	.03750	.03750
77.5	.05570	.04980	.04640	.04330	.03870	.03850	.03830	.03810	.03800	.03790	.03790	.03790	.03790	.03790	.03790	.03790
78.	.05610	.05020	.04680	.04360	.03900	.03880	.03860	.03840	.03830	.03820	.03820	.03820	.03820	.03820	.03820	.03820
78.5	.05660	.05060	.04710	.04400	.03930	.03910	.03890	.03870	.03860	.03850	.03850	.03850	.03850	.03850	.03850	.03850
79.	.05700	.05100	.04750	.04430	.03960	.03940	.03920	.03900	.03890	.03880	.03880	.03880	.03880	.03880	.03880	.03880
79.5	.05750	.05140	.04790	.04470	.03990	.03970	.03950	.03930	.03920	.03910	.03910	.03910	.03910	.03910	.03910	.03910
80.	.05790	.05180	.04830	.04500	.04020	.04000	.03980	.03960	.03950	.03940	.03940	.03940	.03940	.03940	.03940	.03940
80.5	.05840	.05220	.04860	.04540	.04050	.04030	.04010	.03990	.03980	.03970	.03970	.03970	.03970	.03970	.03970	.03970
81.	.05880	.05260	.04900	.04570	.04080	.04060	.04040	.04020	.04010	.04000	.04000	.04000	.04000	.04000	.04000	.04000
81.5	.05930	.05300	.04940	.04610	.04120	.04100	.04080	.04060	.04040	.04030	.04030	.04030	.04030	.04030	.04030	.04030
82.	.05970	.05340	.04980	.04640	.04150	.04130	.04110	.04090	.04070	.04060	.04060	.04060	.04060	.04060	.04060	.04060
82.5	.06020	.05380	.05010	.04680	.04180	.04160	.04140	.04120	.04100	.04090	.04090	.04090	.04090	.04090	.04090	.04090
83.	.06060	.05420	.05050	.04710	.04210	.04190	.04170	.04150	.04130	.04120	.04120	.04120	.04120	.04120	.04120	.04120
83.5	.06110	.05460	.05090	.04750	.04240	.04220	.04200	.04180	.04160	.04150	.04150	.04150	.04150	.04150	.04150	.04150
84.	.06150	.05500	.05130	.04780	.04270	.04250	.04230	.04200	.04190	.04180	.04180	.04180	.04180	.04180	.04180	.04180
84.5	.06200	.05540	.05160	.04820	.04300	.04280	.04260	.04240	.04220	.04210	.04210	.04210	.04210	.04210	.04210	.04210
85.	.06240	.05580	.05200	.04850	.04330	.04310	.04290	.04270	.04250	.04240	.04240	.04240	.04240	.04240	.04240	.04240
85.5	.06290	.05620	.05240	.04890	.04370	.04350	.04330	.04310	.04290	.04280	.04280	.04280	.04280	.04280	.04280	.04280
86.	.06330	.05660	.05280	.04920	.04400	.04380	.04360	.04340	.04320	.04310	.04310	.04310	.04310	.04310	.04310	.04310
86.5	.06380	.05700	.05310	.04960	.04430	.04410	.04390	.04370	.04350	.04340	.04340	.04340	.04340	.04340	.04340	.04340
87.	.06420	.05740	.05350	.04990	.04460	.04440	.04420	.04400	.04380	.04370	.04370	.04370	.04370	.04370	.04370	.04370
87.5	.06470	.05780	.05390	.05030	.04490	.04470	.04450	.04430	.04410	.04400	.04400	.04400	.04400	.04400	.04400	.04400
88.	.06510	.05820	.05430	.05060	.04520	.04500	.04480	.04460	.04440	.04430	.04430	.04430	.04430	.04430	.04430	.04430
88.5	.06560	.05860	.05460	.05100	.04550	.04530	.04510	.04500	.04470	.04460	.04460	.04460	.04460	.04460	.04460	.04460
89.	.06600	.05900	.05500	.05130	.04580	.04560	.04540	.04520	.04500	.04490	.04490	.04490	.04490	.04490	.04490	.04490
89.5	.06650	.05940	.05540	.05170	.04620	.04600	.04580	.04560	.04540	.04520	.04520	.04520	.04520	.04520	.04520	.04520
90.	.06690	.05990	.05580	.05200	.04650	.04630	.04610	.04590	.04570	.04550	.04550	.04550	.04550	.04550	.04550	.04550
90.5	.06740	.06030	.05610	.05240	.04680	.04660	.04640	.04620	.04600	.04580	.04580	.04580	.04580	.04580	.04580	.04580
91.	.06780	.06070	.05650	.05270	.04710	.04690	.04670	.04650	.04630	.04610	.04610	.04610	.04610	.04610	.04610	.04610
91.5	.06830	.06110	.05690	.05310	.04740	.04720	.04700	.04680	.04660	.04640	.04640	.04640	.04640	.04640	.04640	.04640
92.	.06870	.06150	.05730	.05340	.04770	.04750	.04730	.04710	.04690	.04670	.04670	.04670	.04670	.04670	.04670	.04670
92.5	.06920	.06190	.05760	.05380	.04800	.04780	.04760	.04740	.04720	.04700	.04700	.04700	.04700	.04700	.04700	.04700
93.	.06960	.06230	.05800	.05410	.04830	.04810	.04790	.04770	.04750	.04730	.04730	.04730	.04730	.04730	.04730	.04730
93.5	.07010	.06270	.05840	.05450	.04870	.04850	.04820	.04800	.04780	.04760	.04760	.04760	.04760	.04760	.04760	.04760
94.	.07050	.06310	.05880	.05480	.04900	.04870	.04850	.04830	.04810	.04790	.04790	.04790	.04790	.04790	.04790	.04790
94.5	.07100	.06340	.05910	.05520	.04930	.04910	.04890	.04870	.04850	.04830	.04830	.04830	.04830	.04830	.04830	.04830
95.	.07140	.06390	.05950	.05550	.04960	.04940	.04920	.04900	.04880	.04860	.04860	.04860	.04860	.04860	.04860	.04860
95.5	.07190	.06430	.05990	.05590	.04990	.04970	.04950	.04930	.04910	.04890	.04890	.04890	.04890	.04890	.04890	.04890
96.	.07230	.06470	.06030	.05620	.05020	.05000	.04980	.04960	.04940	.04920	.04920	.04920	.04920	.04920	.04920	.04920
96.5	.07280	.06510	.06060	.05660	.05050	.05030	.05010	.04990	.04970	.04950	.04950	.04950	.04950	.04950	.04950	.04950
97.	.07320	.06550	.06100	.05690	.05080	.05060	.05040	.05020	.05000	.04980	.04980	.04980	.04980	.04980	.04980	.04980
97.5	.07370	.06590	.06140	.05730	.05110	.05090	.05070	.05050	.05030	.05010	.05010	.05010	.05010	.05010	.05010	.05010
98.	.07410	.06630	.06180	.05760	.05150	.05120	.05100	.05080	.05060	.05040	.05040	.05040	.05040	.05040	.05040	.05040
98.5	.07460	.06670	.06210	.05800	.05180	.05150	.05130	.05110	.05090	.05070	.05070	.05070	.05070	.05070	.05070	.05070
99.	.07500	.06710	.06250	.05830	.05210	.05180	.05160	.05140	.05120	.05100	.05100	.05100	.05100	.05100	.05100	.05100
99.5	.07550	.06750	.06290	.05870	.05240	.05210	.05190	.05170	.05150	.05130	.05130	.05130	.05130	.05130	.05130	.05130
100.	.07590	.06790	.06330	.05900	.05270	.05240	.05220	.05200	.05180	.05160	.05160	.05160	.05160	.05160	.05160	.05160

TABLE IV.—FUEL OIL CHART.

Degrees Baume	Specific Gravity	Lbs. Per U. S. Gallon	Cu. Ft. Per Long Ton	Degrees Baume	Specific Gravity	Lbs. Per U. S. Gallon	Cu. Ft. Per Long Ton
10.0	1.0000	8.3280	35.956		.9370	7.8033	38.373
	.9990	8.3190	35.992	19.5	.9365	7.7990	38.390
	.9980	8.3110	36.028		.9360	7.7950	38.414
	.9970	8.3030	36.064		.9350	7.7860	38.455
10.5	.9964	8.2990	36.080		.9340	7.7780	38.496
	.9960	8.2940	36.100	20.0	.9333	7.7720	38.520
	.9950	8.2860	36.140		.9330	7.7700	38.538
	.9940	8.2780	36.174		.9320	7.7610	38.579
11.0	.9930	8.2690	36.210		.9310	7.7530	38.621
	.9920	8.2610	36.250	20.5	.9300	7.7450	38.662
	.9910	8.2530	36.282		.9290	7.7367	38.704
	.9900	8.2447	36.319		.9280	7.7283	38.745
11.5	.9894	8.2400	36.330	21.0	.9270	7.7200	38.787
	.9890	8.2360	36.356		.9260	7.7110	38.829
	.9880	8.2280	36.392		.9250	7.7034	38.871
	.9870	8.2200	36.429	21.5	.9240	7.6950	38.913
12.0	.9860	8.2110	36.466		.9230	7.6860	38.955
	.9850	8.2030	36.503		.9220	7.6780	38.998
	.9840	8.1940	36.540	22.0	.9210	7.6700	39.040
	.9830	8.1860	36.578		.9200	7.6617	39.082
12.5	.9825	8.1820	36.590		.9190	7.6530	39.125
	.9820	8.1780	36.615	22.5	.9180	7.6450	39.167
	.9810	8.1690	36.652		.9170	7.6360	39.210
	.9800	8.1614	36.689		.9160	7.6280	39.253
13.0	.9790	8.1530	36.727	23.0	.9150	7.6200	39.296
	.9780	8.1440	36.765		.9140	7.6110	39.339
	.9770	8.1340	36.802		.9130	7.6030	39.382
	.5760	8.1280	36.840	23.5	.9120	7.5950	39.425
13.5	.9756	8.1250	36.860		.9110	7.5860	39.468
	.9750	8.1190	36.878		.9100	7.5784	39.512
	.9740	8.1110	36.915	24.0	.9090	7.5700	39.555
	.9730	8.1030	36.953		.9080	7.5610	39.599
14.0	.9720	8.0940	36.991		.9070	7.5530	39.642
	.9710	8.0860	37.030	24.5	.9060	7.5450	39.686
	.9700	8.0781	37.068		.9050	7.5360	39.730
	.9690	8.0698	37.106		.9040	7.5280	39.774
14.5	.9688	8.0690	37.110	25.0	.9030	7.5200	39.818
	.9680	8.0610	37.144		.9020	7.5110	39.862
	.9670	8.0530	37.183		.9010	7.5030	39.906
	.9660	8.0440	37.221	25.5	.9000	7.4952	39.951
15.0	.9655	8.0410	37.240		.8990	7.4860	39.996
	.9650	8.0360	37.260		.8980	7.4780	40.040
	.9640	8.0280	37.298	26.0	.8974	7.4730	40.060
	.9630	8.0190	37.337		.8970	7.4700	40.083
15.5	.9620	8.0110	37.376		.8960	7.4610	40.129
	.9610	8.0030	37.415		.8950	7.4530	40.174
	.9600	7.9948	37.454	26.5	.8946	7.4490	40.190
	.9590	7.9865	37.493		.8940	7.4450	40.219
16.0	.9589	7.9860	37.500		.8930	7.4360	40.264
	.9580	7.9780	37.532		.8920	7.4280	40.309
	.9570	7.9690	37.571	27.0	.8917	7.4250	40.330
	.9560	7.9610	37.611		.8910	7.4200	40.354
16.5	.9556	7.9590	37.630		.8900	7.4119	40.400
	.9550	7.9530	37.650		.8890	7.4030	40.445
	.9540	7.9449	37.689	27.5	.8889	7.4020	40.450
	.9530	7.9360	37.729		.8880	7.3950	40.491
17.0	.9524	7.9310	37.740		.8870	7.3860	40.536
	.9520	7.9280	37.769	28.0	.8860	7.3780	40.582
	.9510	7.9190	37.808		.8850	7.3700	40.628
	.9500	7.9116	37.848		.8840	7.3610	40.674
17.5	.9492	7.9040	37.870	28.5	.8830	7.3530	40.720
	.9490	7.9032	37.888		.8820	7.3450	40.766
	.9480	7.8940	37.928		.8810	7.3360	40.814
	.9470	7.8860	37.968	29.0	.8800	7.3286	40.859
	.9460	7.8780	38.008		.8790	7.3200	40.905
18.0	.9459	7.8770	38.010		.8780	7.3110	40.952
	.9450	7.8690	38.048	29.5	.8777	7.3090	40.970
	.9440	7.8610	38.089		.8770	7.3030	40.999
	.9430	7.8530	38.129		.8760	7.2950	41.045
18.5	.9428	7.8510	38.140	30.0	.8750	7.2870	41.092
	.9420	7.8444	38.170		.8740	7.2786	41.139
	.9410	7.8360	38.210		.8730	7.2700	41.186
	.9400	7.8283	38.251	30.5	.8723	7.2640	41.220
19.0	.9396	7.8256	38.270		.8720	7.2620	41.234
	.9390	7.8190	38.291		.8710	7.2530	41.280
	.9380	7.8110	38.332		.8700	7.2450	41.328

rected specific gravity, the tons and parts of a ton can be found by Table IV, which gives the number of cubic feet contained in a ton of oil for the different specific gravities. Dividing the corrected volume by the cubic feet shown opposite the corrected specific gravity will give the tons of oil.

Examples

Case No. 1.—7,520 barrels, 18 Baume, 72 degrees Fahrenheit.

From Table I we find opposite 72 degrees F. the multiplier 0.995223. Multiplying 7,520 by 0.995223 gives 7484.07 as the correct amount at the standard temperature.

Case No. 2.—7,520 barrels, 18 Baume, 20 degrees Centigrade.

From Table II we find opposite 20 degrees C. the multiplier 0.99681. Multiplying 7,520 by 0.99681 gives 7,496.01 as the correct amount at the standard temperature.

Case No. 3.—15,500 cubic feet, 0.94 specific gravity, 24 degrees Centigrade.

From Table II opposite 24 degrees Centigrade we find the multiplier 0.9939588. Multiplying 15,500 by this gives 15,406.36 as the correct amount at the standard temperature. From Table III under 0.94 specific gravity and opposite 24 degrees Centigrade we find the constant 0.0051, which must be added to the specific gravity of 0.94, giving 0.9451 as the corrected specific gravity at the standard temperature. From Table IV opposite 0.9450 we find 38.048 cubic feet to a ton, and by interpolation we find that 0.9451 would be 38.043 cubic feet to the ton. Dividing the corrected volume 15,406.36 by 38.043 gives 404.9722 tons as the correct amount, and this reduced to the English measure gives 404 tons 19 hundredweight 1 quarter 18 pounds.

These calculations might seem tedious and unnecessary, but with the high price of fuel and the great difference caused by expansion it is absolutely necessary to make them so that a correct check can be had on the amount bought.

The tables referred to above have been made up from data published by the United States Government and are reasonably correct.

Examples Showing How to Apply Temperature Correction Table

Explanation.—Referring to the temperature correction table, 15.6 degrees Centigrade equals the normal temperature of fuel oil. The figure opposite 15.6 degrees Centigrade is 1.0000, which is the multiplier at this particular temperature.

Fuel oil at a temperature below 15.6 degrees Centigrade shows a contraction in its volume with a corresponding increase in its multiplier as shown in the table.

Fuel oil at temperatures above 15.6 degrees Centigrade shows an expansion in its volume with a corresponding decrease in its multiplier as shown in table.

Rule.—Multiply barrels or cubic feet of fuel oil under consideration by multiplier in column opposite temperature of oil under consideration.

Example.—Temperature below 15.6 degrees Centigrade. Referring to chart, 10 degrees Centigrade = 1.00402 multiplier; 500 barrels or cubic feet of fuel oil at 10 degrees Centigrade. Then, 500 × 1.00402 = 502.01 barrels or cubic feet, net amount fuel oil.

Example.—Temperature above 15.6 degrees Centigrade; 500 barrels or cubic feet at 25 degrees Centigrade. Referring to chart, 25 degrees Centigrade = .993246. Then, 500 × .993246 = 496.623 barrels or cubic feet fuel oil = net amount.

Standardization of Petroleum Specifications

ORGANIZATION of the Interdepartmental Committee on Standardization of Petroleum Specifications, which supersedes the war-time committee on the same subject, was effected at the first meeting of the Committee held at the Bureau of Mines, Washington, D. C., February 19. In addition, the Committee gave its approval to Bulletin 5 of the old Committee, thus continuing in force the specifications on gasoline, kerosene, fuel oils, lubricating oils, signal oils, etc., contained in that bulletin. The Committee further decided to adopt the plan of adding a technical sub-committee to handle the details of drawing up and revising specifications and methods of testing. Dr. H. Foster Bain, acting director of the Bureau of Mines, appointed N. A. C. Smith, petroleum chemist, to represent him as chairman of the technical committee.

Mold Loft Suggestions—II

Development of Longitudinals in Isherwood Construction—Miscellaneous Problems

BY J. I. HESS*

THE method of developing the shell described in the last issue is admirably adapted to determining the shape of the longitudinals in the Isherwood type of construction. But it is necessary to locate the inboard heel of the longitudinal on the body plan before beginning the work of development. The method of locating this line is simple, but before taking that up it will be of interest to describe, briefly, the bevel board and its application to this particular problem.

The Bevel Board

The bevel board consists of numerous radii dividing an arc into degrees, as shown in Fig. 8. Draw a straight horizontal line. At any point *O* on this line, and with any convenient radius, say 24 inches, draw an arc of 90 degrees. If this arc be divided into 90 equal parts, each segment will subtend an angle of one degree at the center *O*. From *O* draw lines of indefinite length through these division points and we have the basis of the bevel board. The first 45 degrees or 50 degrees up from the horizontal base line are all that will be needed.

We will assume that the frame spacing is 24 inches. From *O* measure out 24 inches on the horizontal line to *B* and erect a perpendicular. Use a hardwood stick about 30 inches long and 1 inch wide and 3/16 inch thick, with beveled edges, if desired. Lay it along the perpendicular just erected, with the end flush with the base at *B*, and pick up each intersection, numbering them from *O* at the end of the stick up to 45, or more if needed. These points should be squared across the stick so that both edges will be the same. When this is done, mark the stick in some conspicuous place with the frame space for which it was made (24 inches in this case) and make a similar stick for each different spacing.

To find the bevel of a frame at any point, place the stick at right angles to the molded line, with the end at the point in question, and read the required bevel at the point of intersection with the next frame. For most conditions a bevel stick made on a base of one frame space gives results close enough, but in the extreme after body, or where the bevel is changing rapidly from frame to frame, it is necessary to use two frame spaces as the base. In this case the stick is applied across two frame spaces on the body plan and the bevel thus obtained is for the frame in between. The reason for this is seen in Fig. 9. The angle *BAC* will be the bevel of the frame at *D*, since the line *AC* is approximately parallel to the tangent to the curve at the point *D*.

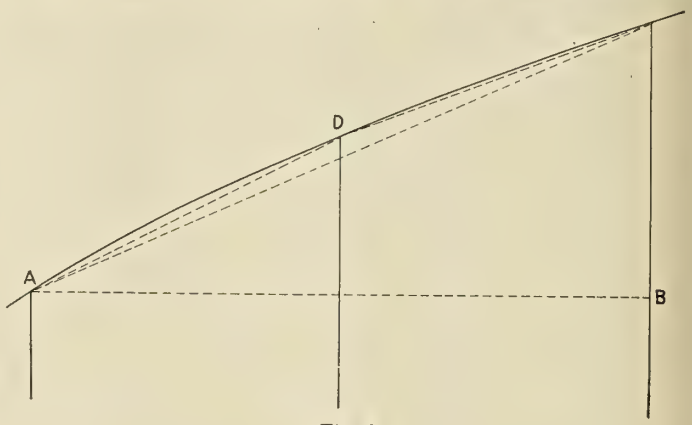

Fig. 9

In the body plan of an Isherwood boat it is necessary to use auxiliary frame lines, spaced not more than 30 inches, for the purpose of "fairing up." In Fig. 10 let *AC* and *BD* be any two such adjacent frames and the figure, as shown, a portion of a longitudinal. Draw *AF* perpendicular to *DB* and *AE* perpendicular to *CD*. For all practical purposes *ABDC* may be considered a parallelogram, from which assumption it is easily seen that angle *EAC* = angle *BAF*, or the angle of bevel. (Similar triangle.) From this it will be seen that *AC*, the distance between heels of the longitudinal in the plane of the frame, will be the width of the member *EA* divided by the cosine of the angle of bevel *EAC*, or

$$AC = \frac{EA}{\text{Cos } \phi}.$$

As a matter of convenience, we should pick up these varying values of *AC* on a stick to be used in connection with the bevel stick in spotting the points *D*, *C*, etc., on the floor. To illustrate the method of procedure, let us assume that we are working on a 12-inch channel. In Fig. 8 measure

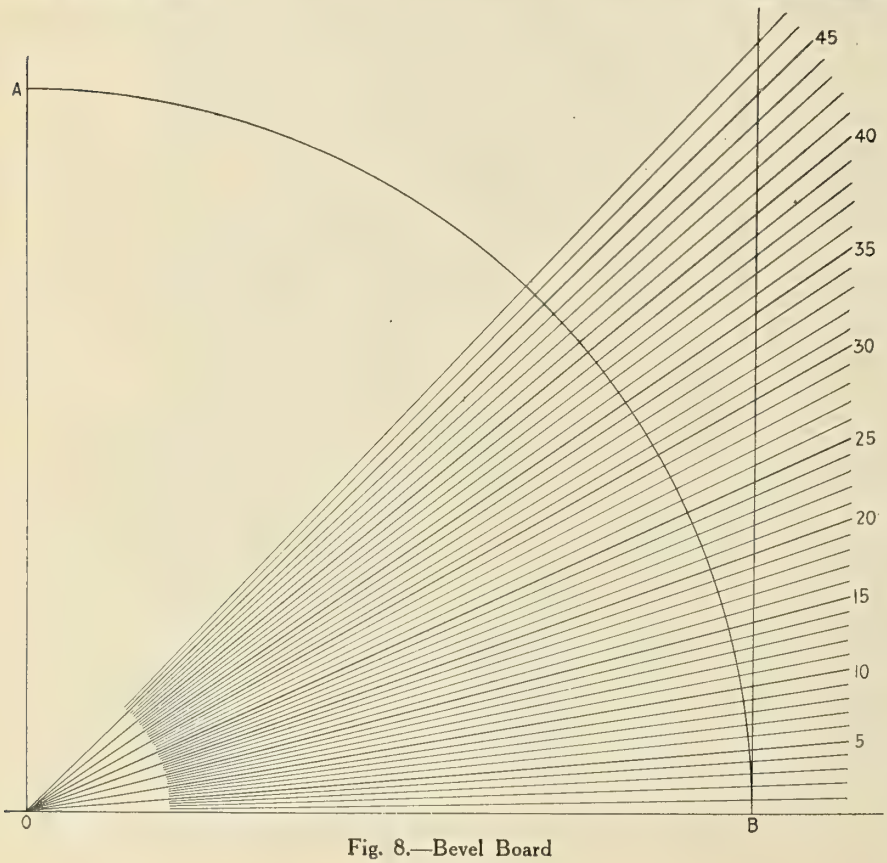

Fig. 8.—Bevel Board

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out 12 inches from O to B and erect a perpendicular. Use a stick like the bevel stick, and with any pitch mark near its end held on O pick up the length of the hypothenuse for each variation in the angle at O. (It is better to use a pitch mark rather than the end of the stick, owing to its greater accuracy.) These points will be marked with the degree of angle to correspond with the marking on the bevel stick.

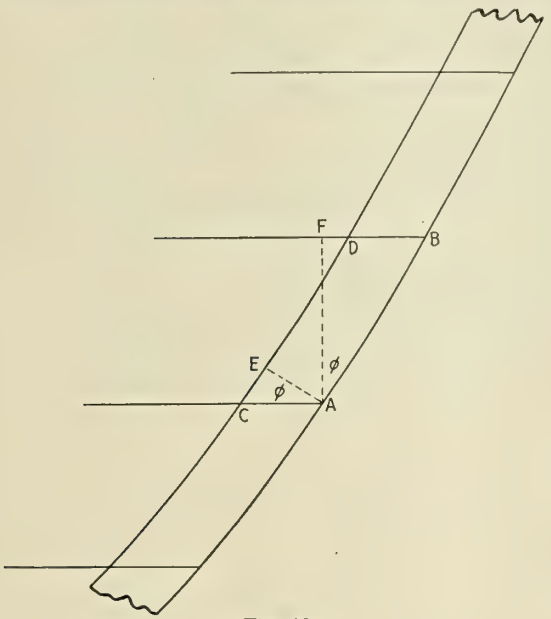


Fig. 10

Similar scales should be prepared for each width of longitudinal used, and considerable care should be taken to insure accuracy. For convenience we shall call these longitudinal sticks."

In Fig. 11 let $A'B'$ be the molded heel of the longitudinal under consideration. From each intersection made by this line with the molded frames square a line inboard from the frame as shown. These will correspond to the lines DB, CA, etc., in Fig. 10 and will lie in the plane of the frames. Now apply the proper bevel stick between the frames A' and B'—not along the line $A'B'$, but at right angles to the frame at A'

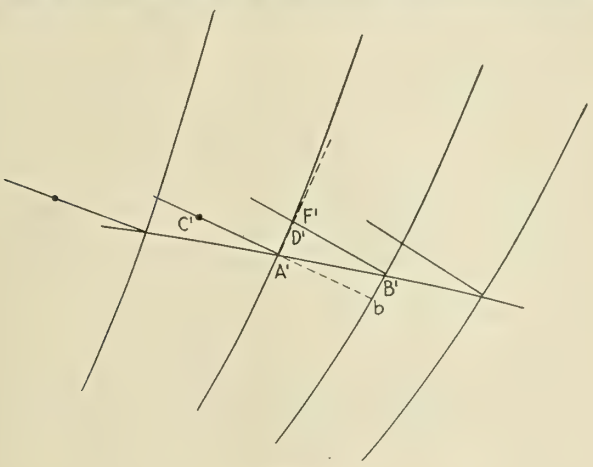


Fig. 11

or along the line $C'A'$ produced. Let us suppose it reads 30 degrees. With the pitch mark at A' apply the longitudinal stick just described along the line $C'A'$, and at 30 spot the point C'. In a like manner the inboard heel is located at each frame. When that is done the development proceeds as described for the shell.

Right here we must watch for an error. In Fig. 10 angle FAB will be the angle of bevel only when AB coincides with Ab, Fig. 11. This seldom, if ever, happens, but where the adjacent frames are approximately parallel near the longitudinal the difference in the two angles will rarely be enough to consider. However, we must know that such a condition exists and make proper allowance for it when necessary.

At A' erect a perpendicular to $C'A'$. It will intersect $B'D'$ at F'. Then angle $F'A'B'$ in Fig. 11 must be the projection of an angle whose true size is FAB in Fig. 10. The difference between that angle (ϕ) and the bevel of the frame at A will then be due to the difference between the lengths of $F'B'$ and $A'b$ on one side of the triangle and the expanded frame space FA and the true frame space on the other.

While this difference is usually negligible in all members that stand normal to the frame (because $F'B'$ is usually enough longer than $A'b$ to offset the increased length of the expanded frame space), it must be considered in all cases where the angle in question lies in a plane that approaches the horizontal or crosses the frame at an angle other than 90

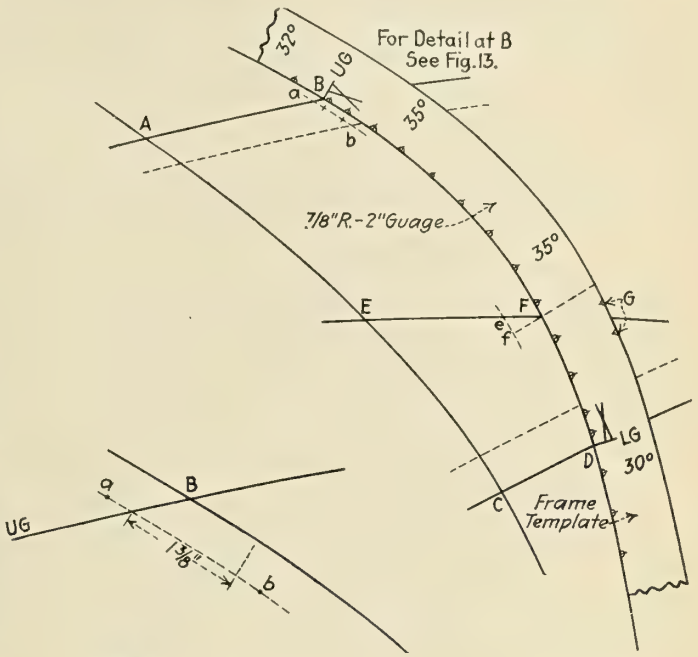


Fig. 12

Fig. 13

degrees. This will be illustrated later in a discussion of the deck stringer bar.

When the expansion is complete there will be two long, parallel lines of battens tacked to the floor. A positive check on the accuracy of the work will be found in measuring the distance between them. If it is a 12-inch channel, then EA should be exactly 12 inches at every point. If it fails in this, a recheck of the development work will probably disclose the error.

These longitudinal sticks are very essential in determining the depth of the cutout in the transverse to allow for the free passage of the longitudinal. A careless loftsman can easily make a poor "guess" in this and cause expensive delay in assembling on the ways. Owing to the angle at which the transverse and the longitudinal intersect (angle CAE, Fig. 10), a 12-inch channel may easily require more than 15 inches clearance from the shell to allow free passage. Simply locate the inboard heel on the template while on the floor by the method shown in Fig. 12 and add on the proper amount of clearance.

It is well to remember that, if the longitudinal is on an outside strake of plating, better results will be obtained if the development work is carried on from a line on the inside edge of the shell, or the actual location of the heel, rather than from the molded line; but, as in the shell expansion, this will not always be necessary. It will, however, be necessary in determining the depth of the cutout just referred to.

Few loftsmen take full advantage of the opportunities offered by a study of the bevel board's uses. Besides the longitudinal sticks already described, there are several other equally useful scales that can be made from it. Numerous problems in descriptive geometry are encountered by the man

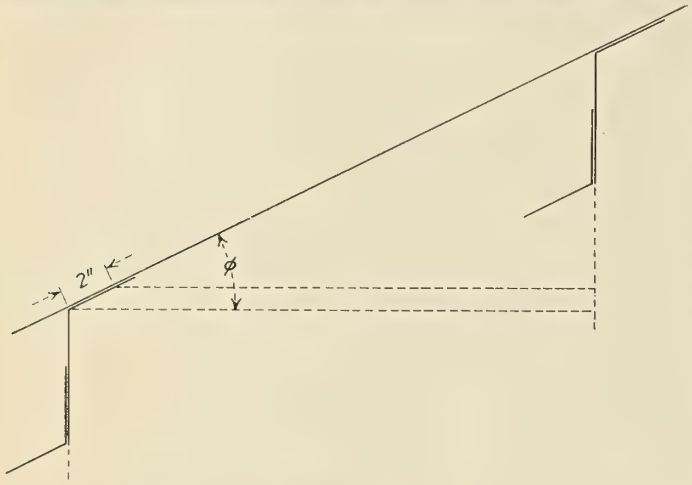


Fig. 14

who works on the lines and, while most of them are usually overlooked, they are important. An intelligent use of these scales helps to solve many of them.

MISCELLANEOUS

One such problem occurs where the edge of a shell plate crosses the molded frame at a sharp angle, when the frame has considerable bevel, as often happens in the after peak.

In Fig. 12 let *AB* and *CD* be the upper and lower edges, respectively, of a shell plate in the after body. A common form of frame template is shown with the holes in the shell flange marked on the heel. If the shell flange is 3½ inches wide, the rivet gage will be 2 inches from the heel. Where there is bevel in the frame, as at *B*, the projection of this 2-inch gage line will lie some place between the two frames. A glance at Fig. 14 shows that the distance from *B* to this projection will be $2 \times \sin \phi$, where ϕ is the angle of bevel.

If we turn to Fig. 8 and draw an arc with a radius of 2 inches about *O* as a center we get this distance for any degree of bevel by dropping perpendiculars from the points of intersection of the arc and the radii to the base *AB*. It will be found very convenient to have these distances, together with the scales described later, picked up on a small stick to be carried in the pocket like a rule.

Choose a piece of hard, light-colored wood (lignum vitae is good) 6 inches long and 1¼ inches wide with beveled edges and diamond-shaped cross-section. With the end of the stick on the base line *OB*, Fig. 8, pick up these various heights and number the points to correspond with the degree of angle, as was done with the bevel stick (see Fig. 15, scale "*A*").

Suppose we apply the bevel stick to the frame at *B*, Fig. 13, and find 35 degrees. Place the end of the scale just made at right angles to the frame at *B* and at 35 spot a point. Through this point draw a short line across the sight edge of the plate and parallel to the molded frame, as at *ab*. The seam holes can then be spaced in on this line, with the proper landing from the edge of the plate, and squared back to the heel for record on the template. It is customary in some lofts to measure this landing directly on the heel of the frame. It will be seen from Fig. 13 that holes so located will not be in a fair line with the rest of the seam holes, and unless they are drawn back into line they will be too near the edge when the plate is sheared. If they are so drawn in they will not fit the frame and the frame holes will later have to be welded.

This correction is necessary only when the shell at that point is to be molded after the frame is made, which is usually the case. If the shell is done first and a record of the holes transferred from it to the frame, this error will not occur.

In Fig. 15 scales "*B*" and "*C*" are made in the same manner as scale "*A*" and used similarly. With *O* as a center and with a radius of 4½ inches, strike an arc as before and pick up the vertical distances from the intersections to the base *OB*. This gives us scale "*B*."

In a 6-inch by 6-inch bar the rivets near the toe will be spaced on a gage line that is 4½ inches from the heel. By the use of scale "*B*," as described for "*A*," any point in this line can be located on the body plan. At first thought there seems to be little need of this, but the worker will find numerous places where it is of advantage.

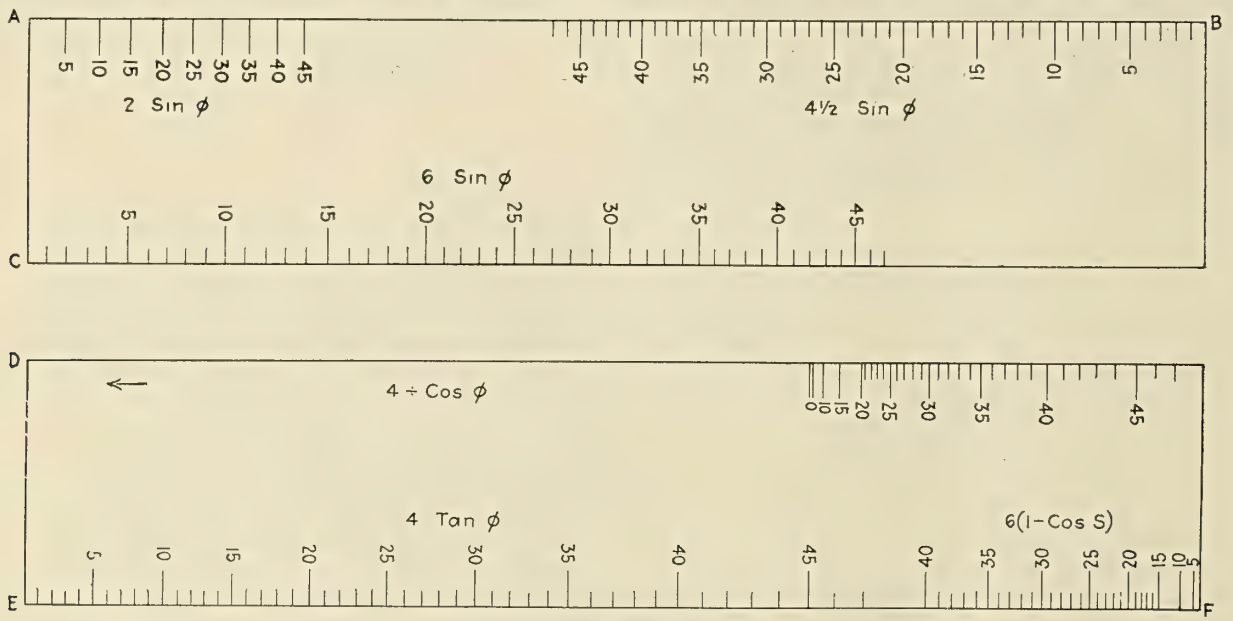


Fig. 15

Scale "*C*" will do nothing that cannot be done with "*B*," but there will be found occasions when it is more convenient to use. It is made on a base of 6 inches instead of 4½, and with its aid one can locate the toe of a 6-inch shell bar and get the angle of cut in way of the shell longitudinals. The panting stringers in a transverse framed boat also offer a good illustration of its use.

If the stringer bar is a 3½-inch by 7-inch angle the two holes in the 7-inch flange at each frame may be located on the heel of the template of the 3½-inch flange and thus save the time and labor of making an extra template. When there is much vertical "set" in the bar it will be necessary to make a smith mold of the wider flange, but a laying-out template will not be needed.

In Fig. 12 let *EF* be the molded heel of the stringer shell-clip. With the bevel stick we find a 33-degree bevel in the frame at *F*. Place scale "*C*" at right angles to the frame with the end at *F*, and at 33 thereon spot a point on the floor. Through this point draw the line *ef* parallel to the molded frame. We know, then, that this is the projection of a line that is 6 inches from the heel of the frame and lying in the plane of the shell flange. We also know that since *ef* is parallel to the frame it must be parallel to the plane of projection. Hence *ef* is the true length of the line.

From the description of Fig 3 (page 132, February issue) we learn that a line drawn through *F* perpendicular to the molded frame at that point must be the projection of a line that is at right angles to the frame. There *Ff* must be 6

In Fig. 16 draw any horizontal line *EF* to represent the inches.

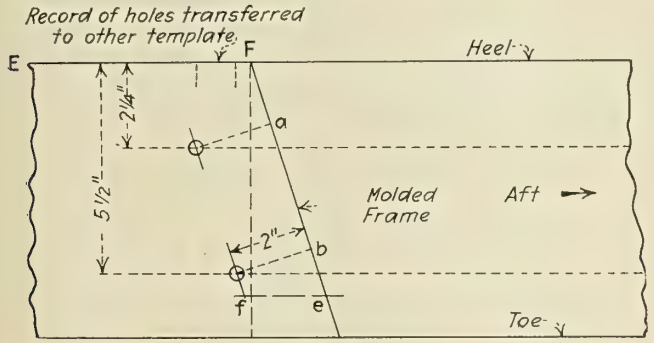


Fig. 16

heel of the stringer bar, and at *F* drop a perpendicular. If we measure down on this line 6 inches and over at right angles the distance *ef*, just found in Fig. 12, we strike a point in the heel of the frame. That is, the angle *EFD* in Fig. 12 is a projection of the angle whose true size is *EFf* in Fig. 16.

If the frame is a channel the holes will be located as shown in Fig. 16, unless there is too much bevel to allow easy riveting. In that case the bar will be held in place by a clip on the back of the channel, but in either method the solution is the same. When the holes are properly located, square up to the heel, and these points, in relation to *F*, will be the location of the holes when transferred to the template of the 3½-inch flange.

A similar problem occurs in the location of the holes at *G*, Fig. 12, in the inboard flange of the channel to take the bar. If we square in from *F* to the inboard edge of the template (made the width of the channel), we locate the top of the stringer plate. The error of measuring down from this point the thickness of the plate plus the gage of the rivets is very commonly made. A glance at Fig. 16 shows us that the proper measurements will be the distances *Fa* and *Fb* below the bottom edge of the stringer plate. Were this correction not made the bar would be too low and the molded shell and bulkhead clips would be worthless.

When clips are used to hold the bar to the channel, the precautions must be taken in locating the holes in the channel's web.

Bevels

The finding of the true bevel of a bar from its projection on the body plan many times offers a perplexing problem. The section of the angle shown on the floor lies in the plane of the frame and not at right angles to the heel. Hence, to find the true size of the angle it is necessary to pass a plane through the bar perpendicular to the heel and revolve it into the plane of projection.

The simplest illustration of this will be one in which one flange of the bar lies in a horizontal plane. Take, for instance, the bounding bar of the recess flat to the shell.

In Fig. 17 let *CA* and *EB* be two adjacent frames and *AB* the molded line of the recess flat, as shown on the body plan. Draw any line *CE* at any convenient distance from *AB* and parallel to it. Then *CE* must be parallel to the toe of the

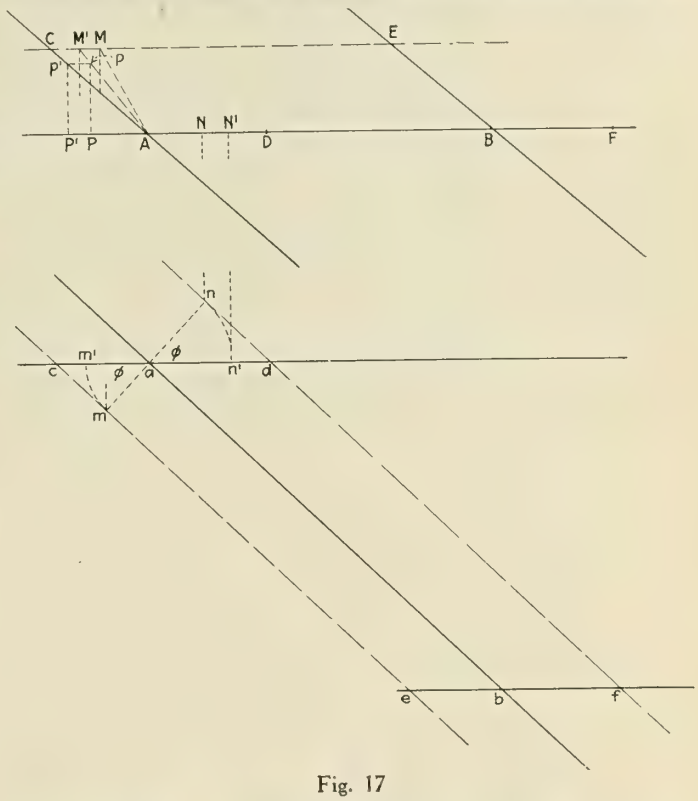


Fig. 17

standing flange. Since the deck flange of the bar lies in a horizontal plane, both the heel and the toe will coincide in the line *AB*.

In the horizontal projection *cd* and *ef* are the two adjacent frame lines. Then *C* falls at *c*, *A* at *a*, *B* at *b*, etc. If a plane *nam* be passed through *a* perpendicular to the heel, the intersection thus formed will show the true bevel of the bar and will be the angle sought.

Since the line *an* lies in the horizontal flange, the vertical projection of *n* will fall at *N* in the line *AB*. Likewise, the point *m* will lie in the line *CE* at *M*. Hence the angle *NAM* is the vertical projection of the angle under consideration.

If a vertical line be passed through the apex of this angle at *a* and used as an axis of rotation, *m* will move around to *m'* and *n* to *n'*. At the same time *N* travels to *N'* in the line *AB* and *M* to *M'* in the horizontal line *CE*. Therefore angle *N'AM'* is the angle required.

While this method gives perfect results, it is not always convenient to draw a horizontal projection. What the loftsman needs is a method of getting this angle directly from the body plan. An analysis of the small triangle *cma* shows that

$$\frac{ma}{ca} = \cos\phi, \text{ or } ca = \frac{ma}{\cos\phi}.$$

Since ϕ is known, we can assume any value for *ma* and find the corresponding value of *ca*. It will be noticed that this is the same formula used in getting the scales on the longitudinal sticks referred to earlier in this article. By assuming 4 inches as the base we have room on our 6-inch pocket piece for scale "*D*" (Fig. 15), which is obtained by picking up the lengths of the various hypothenuses made when a perpendicular is erected to the base *OB* at a point 4 inches distant from *O*.

When scale "*D*" is used, all we need to know to determine the bevel of the bar is the angle ϕ. If we apply the proper

bevel stick at right angles to the frame at A we get the angle made by the shell flange of the frame in a plane perpendicular to the frame's heel, or the bevel of the frame itself, but the angle we want *lies in the plane of the deck,* or on the beam line AB.

Hence apply the bevel stick along the line AB, with the end at A, and read the angle ϕ at B. Suppose it is 46 degrees. Lay scale "D" along the beam line extended and at 46 spot the point P'. The line PA will be 4 inches long. At P' erect a perpendicular to intersect the molded frame in the point p', and from p' draw a horizontal line to intersect the perpendicular from P in the point p. Then pAN is the required angle.

As the angle CAD approaches 90 degrees it will be found that the perpendicular from P' will not intersect the frame within reasonable limits. To avoid this divide both AP and AP' by the same number (some multiple of 4). The angle found will be the same in each case, if the ratio of AP to AP' is not changed.

When both flanges of the bar are inclined to the horizontal the solution remains the same, so long as the heel of the bar itself is horizontal. In Fig. 18 let CA and EB be two adjacent frames, AM and BN the corresponding molded lines of the margin plate, and AB the molded margin bar. As before, apply the bevel stick to the line AB, where we find, say, 15 degrees. On each side of A lay off 4 inches to the points P, and with scale "D," also on each side of A, spot the two points P' at 15. Then erect the two perpendiculars at P' to intersect the frame lines at C and M respectively. From there draw the two horizontal lines to intersect the perpendiculars from the points P, as shown. Angle $C'AM'$ is the required angle.

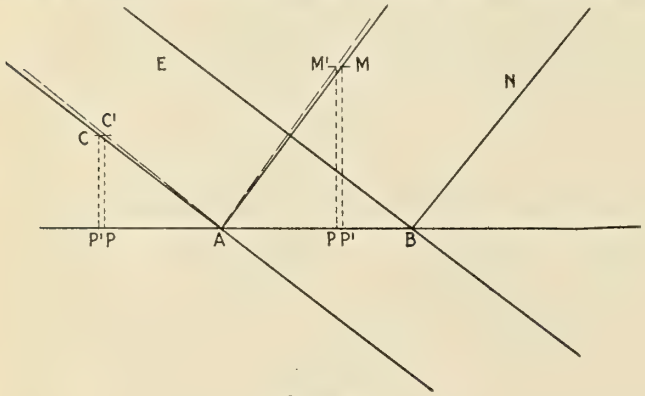


Fig. 18

From this it is seen that as AB grows shorter the angle on the body plan approaches the true angle of the bar. The loftsman, by experimenting a little, will soon learn when the difference in the two angles is enough to consider.

When the heel of the bar makes an angle with the horizontal, another element is introduced that makes the problem much more complicated, and unless the mechanic is sure of his ground it will be better to mock-up a model; but the demonstration is of interest from a mathematical point of view.

In Fig. 19 let CA and EB be two adjacent frames and AD and BF the corresponding beam lines, with AB the molded line of the deck. (The sheer is greatly exaggerated here, purposely, to show the construction of the figure more clearly. By applying the bevel stick at right angles between the beam lines it is found to be 20 degrees.) Any two lines, such as CE and DF, drawn parallel to the heel of the bar AB must be parallel to the toes of the flanges also. At A drop a perpendicular to the next beam line. Then the angle $A'AB$ will be the vertical projection of angle ϕ. To get the true size of this angle we must have a projection in the plane of the deck. In this view of the figure the distance between the beam lines da and fb, or aa', will be the expanded distance due to the sheer shown at AA', while $a'b$ equals $A'B$. Up to 15 degrees of sheer the expansion in the line AA' is enough to make only one degree difference in angle ϕ, when that angle is as much as 40 degrees; and as ϕ decreases, this difference also decreases. Therefore in all ordinary cases the sheer may be neglected in determining ϕ. Simply apply the bevel stick along the line $A'B$ with the end at A and read, say 40 degrees, at B.

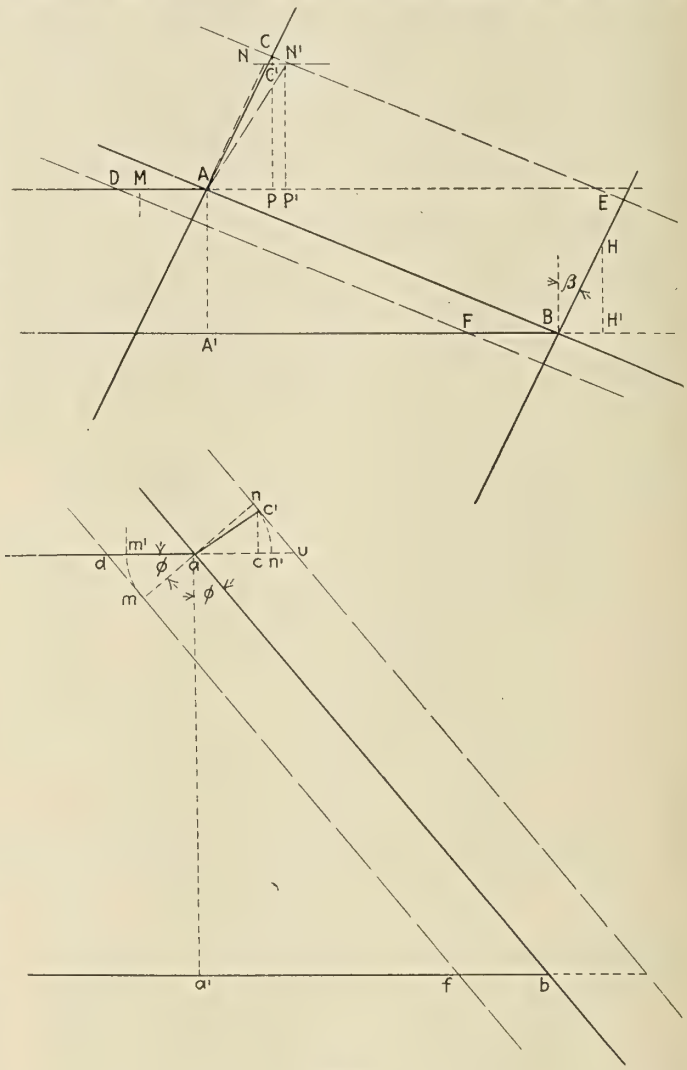


Fig. 19

As before, the problem is to find the true size of an angle made by the intersection of a plane through the bar at right angles to the heel, such as nam. To project the true size of this angle into the vertical it is first necessary to rotate it so that it stands parallel to that plane. If DA be used as an axis of rotation and the bar at B be raised till it lies horizontal, then the lines AB and DF will coincide in the line DA produced. During this operation the point C will move forward through an arc of 20 degrees, with PC as the radius. At the same time the vertical projection of the point C will drop in the perpendicular line PC to C', so that $CC' = PC$ (1 — cos 20 degrees). Then the line CE in its new position will be horizontal through the point C'.

In the horizontal projection c moves to c', so that $cc' = PC$. sin 20 degrees.

By measuring PC and applying it directly to the bevel board these distances may be found and the figures constructed as shown. Then dac' is the projection on the deck of the angle DAC, which in the horizontal is the straight line dac.

As in Fig. 17 the angle may now be revolved around a

vertical line through a as an axis. Then N moves to N' and $N'AM$ is the required angle.

An examination of Fig. 19 shows the following conditions:

$$AP = ac = au - cu.$$
$$AP' = an' = an.$$

In the small triangle $c'cu$

$$(1) \quad cu = cc' \cdot \tan \phi,$$

and in the triangle not shown, in which cc' is one leg and PC the hypothenuse,

$$(2) \quad cc' = PC \cdot \sin S, \text{ where } S \text{ is the angle of sheer in degrees.}$$

Substituting (2) in (1) we get:

$$(3) \quad cu = PC \cdot \sin S \cdot \tan \phi.$$

In triangle anu

$$(4) \quad an = au \cdot \cos \phi = (ac + cu) \cos \phi;$$

then

$$(5) \quad an = (AP + PC \cdot \sin S \cdot \tan \phi) \cos \phi = AP'.$$

If PC be made 6 inches long, the quantity $PC \cdot \sin S$ will be given by scale "C," Fig. 15. The distance AP can be measured on the body plan. That leaves the two unknown variables, tan ϕ and cos ϕ, to be determined. These values may be taken directly from a set of tables and AP computed; or, if there is no book of tables handy, two more scales may be constructed as follows:

In Fig. 8 measure 4 inches out on the base OB from O and erect a perpendicular. With the end of the 6-inch pocket piece on the base pick up the points of intersection on this perpendicular and number them with the degree of angle as was done with the bevel sticks. Call this scale "E."

Again, with a radius of 6 inches and O as a center, Fig. 8, strike an arc and erect a perpendicular to the base of the point where the arc crosses. Then the value of 6 $(1 - \cos S)$ will be the horizontal distance from this perpendicular to the intersections of the arc with the various radii. This will be scale "F," and from it the value of CC' in Fig. 19 is read direct. It shows, also, that the distance CC' in all small angles of sheer may be neglected.

Since scale "D" is based on the formula $(4 \div \cos \phi)$, the cosine of any angle may be found by dividing 4 by the length of the scale out to the number of the degree required. In the same manner tan ϕ is obtained from scale "E."

To find the bevel of a bar inclined both to the horizontal and to the vertical planes, proceed as follows:

Draw a perpendicular to the horizontal line DA, produced to meet the frame in the point C, so that PC equals 6 inches. With the end of scale "F" at C spot point C' at 20, the degree of sheer. Through C' draw a horizontal line.

In equation (5) $AP' = (AP + PC \cdot \sin 20 \cdot \tan 40) \cos 40$. Measure AP on the body plan; measure $PC \cdot \sin 20$ on scale "C"; find tan 40 by dividing 4 into the distance to point 40 on scale "E"; and for cos 40 divide 4 by the distance to point 40 on scale "D." Then equation (5) becomes:

$$AP' = \left(3\tfrac{1}{8} + 2 \times \frac{3.5}{4}\right) \frac{4}{5.25} = 3.9 \text{ inches.}$$

Measure this distance out to P' and erect the perpendicular to intersect the horizontal line through C' at N'. Then $N'AM$ is the angle sought.

To read the bevel in degrees of this or any other angle, such as EBF, Fig. 19, measure 6 inches along the line BE from B to H and drop a perpendicular to the other leg produced. Place scale "C" on BH', with the end at B, and read the degrees at H'.

The value of AP', as given in formula (5), applies only to the outboard flange when the sheer is rising toward the stem in the forward body and toward the stern in the after body. If the inboard flange, also, is inclined to the horizontal under these conditions of sheer, the formula, when applied to that flange, becomes:

$$(6) \quad AP' = (AP - PC \cdot \sin S \cdot \tan \phi) \cos \phi.$$

When the sheer is reversed, the formulas are interchanged; that is, apply (6) to the outboard flange and (5) to the inboard flange.

Electrical Propelling Machinery on the Eclipse Gives Satisfactory Performance on Maiden Voyage

INTERESTING facts on the operation of the S. S. *Eclipse*, America's first electrically propelled merchant vessel, are given in a recent letter to the General Electric Company by A. Starr, engineer of the Locomotive Superheater Company, New York, upon his return to this country after being aboard the *Eclipse* from New York to Port Said, on her first run. In his communication, Mr. Starr says:

"The trip was the most interesting in all my sea experience, making 5,122 miles without a single stop. Although we have had very heavy weather and a poor grade of fuel, we maintained excellent speed for the entire trip.

"The main turbine and motor gave excellent service, the control gear was very easily and efficiently operated by the new personnel, not the slightest trouble of any kind was experienced during the run.

"The boilers and superheaters gave very satisfactory results, maintaining a pressure of 200 to 210 pounds, and a temperature of 585 degrees to 600 degrees at the turbine.

"The chief engineer was very well satisfied with the performance of the entire equipment and especially so, with the simplicity of its operation. The engineer's force of this vessel is not above the average in experience, therefore, when we consider these facts and circumstances, together with the performance of the vessel, it is safe to say that no shipowner would make any mistake by equipping his ships with this type of equipment.

"The engineers on watch operated the apparatus as easily as a motorman does a trolley car; each and every one showed an interest in his respective duty, which was due chiefly to the simplicity of operation, which also created a very harmonious atmosphere, with co-operation and everybody pulling together for the best results.

"The vessel went through some very rough seas, and when the stern was pitched high up out of the water by the heavy swells there was not the least variation noticeable in the revolutions of the main motor and no vibration was felt at any time in any part of the ship during the trip.

"The writer has had many years of seagoing experience in different types of vessels with various equipments, but has never been on any vessel which showed such marked steadiness and entirely devoid of vibration.

"I wish to add that the congenial and harmonious feeling among the entire crew would be hard to find on any ship, which I would say was due to the satisfactory performance and results shown. On our arrival at Port Said, everybody seemed very happy and everything was ready to go ahead to Singapore."

Does Everybody Know?—"Everybody knows," says Senator Edge, "that we cannot be prosperous in this country by attempting to confine the absorption of the products of the country within our own borders. We must do business with the world." But *does* everybody know it? A hundred and one general panaceas have been brought forward as the one best antidote for depression. When everybody finds out that we must do business with the world, and works toward that aim, then and then only will our surplus goods find a way to market.

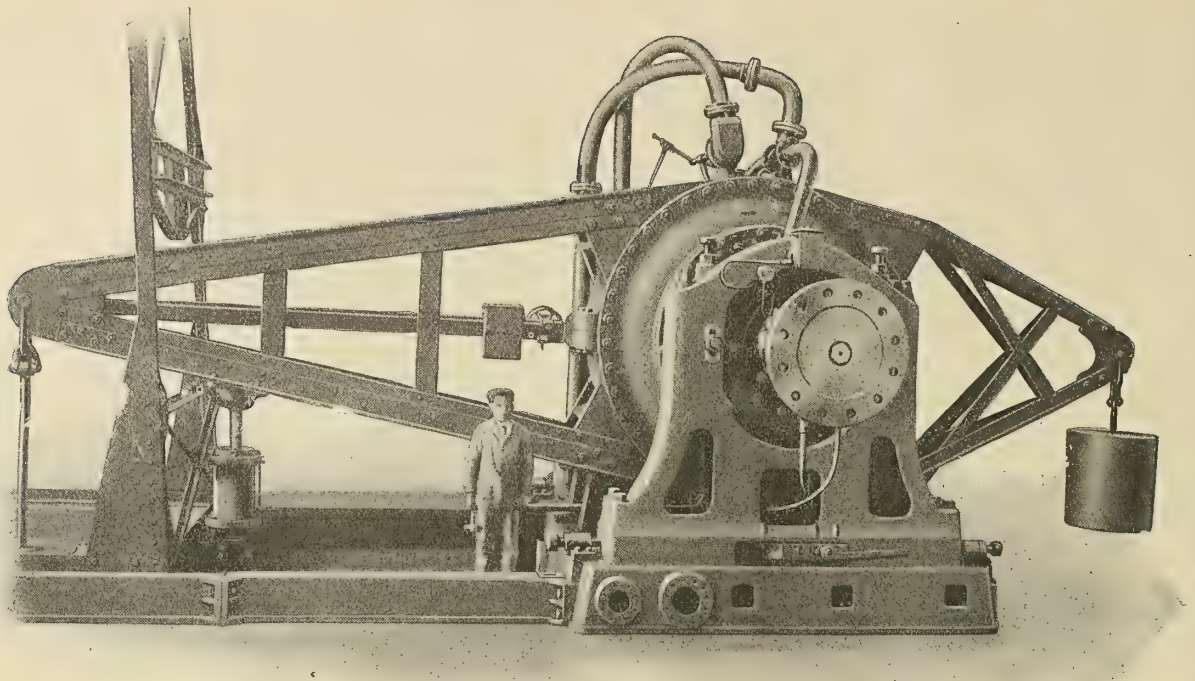


Fig. 1.—Froude Non-Reversible Standard Low Speed Dynamometer, with Rated Maximum Capacity of 6,000 Brake-Horsepower at Speeds of From 100 to 140 Revolutions Per Minute

The Froude Hydraulic Dynamometer

Reversible and Non-Reversible Types Built in Standard Sizes up to 6,000 Horsepower by the C. H. Wheeler Manufacturing Company

BY C. H. PEABODY, DR. ENG.

THE Froude hydraulic dynamometer applies on a grand scale the principle used by Joule in his determination of the mechanical equivalent of heat; Joule used the ordinary physicist's calorimeter, a thin cylindrical metallic can placed on a table. From a frame above came down a vertical shaft carrying a fan with many radial blades. The shaft was driven by cords running over pulleys and carrying weights at the ends. Around the inside of the shell of the can were partial radial partitions which caught the water and aided in churning it. There were provisions for winding up the cords, for checking loss of heat and measuring the rise of temperature of the water. Rowland improved the method by hanging the calorimeter can so that it could turn about the axis of the shaft; then he provided means for preventing rotation of the can and for measuring the torque. He consequently had a small dynametric calorimeter and he drove it from a gas engine.

Froude's hydraulic dynamometer differs from Rowland's dynametric calorimeter in three ways: (1) The shaft is horizontal and carried in bearings for convenience in construction and in application to motors which habitually have horizontal shafts; (2) the dynamometer is large and strong and can absorb large power; (3) there is a continuous flow of water through the dynamometers to carry away the heat generated.

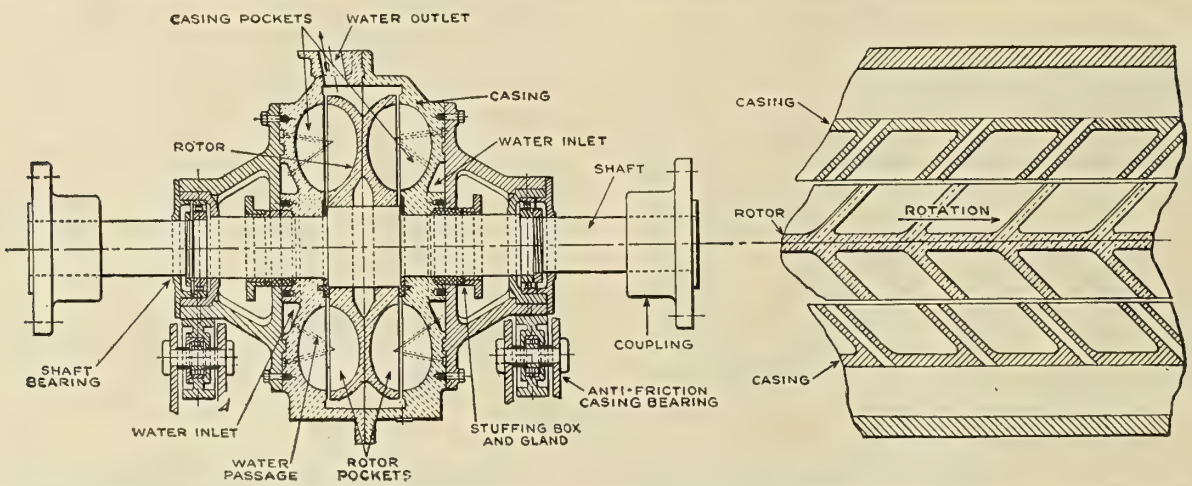


Fig. 2.—Diagrammatic Cross-Section of Non-Reversible Dynamometer, Together With a Developed Cross-Section of Its Principal Water Passages

Fig. 1 gives an external view of the Froude standard low speed dynamometer to absorb 6,000 horsepower at 100 to 140 revolutions per minute; the mechanic standing near gives the scale. Fig. 2 shows a vertical longitudinal section through the axis. A study of these two figures and also of Fig. 3 will make the construction and action of the machines evident.

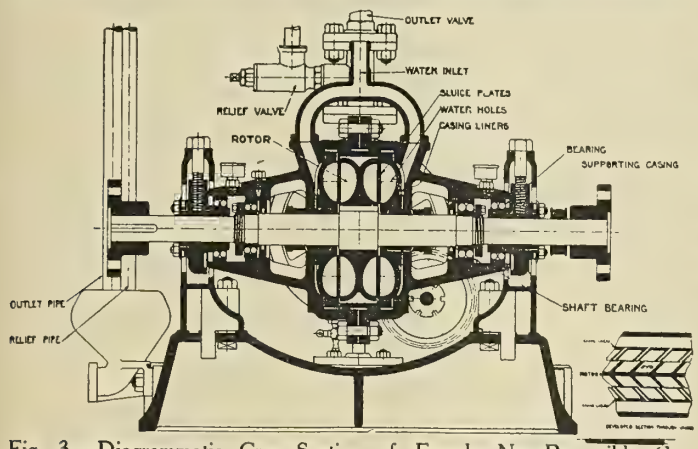


Fig. 3.—Diagrammatic Cross-Section of Froude Non-Reversible Gas Engine Dynamometer, Together With a Developed Cross-Section of Its Principal Water Passages

It should be noted that the two latter figures represent different machines. In the first place, we note the shaft in Fig. 2 and Fig. 3 which has flange couplings at each end so that the machine is both right and left handed and can take on any motor to which it is adapted. At the middle of its length the shaft carries the rotor with half elliptical cups; opposite these cups are similar cups in the casing turned the other way, as is shown by the developed cylindrical section through the cups at the right. The shaft passes through stuffing boxes and is supported in bearings in the casing; the casing in turn is supported by pedestal bearings. Thus the shaft runs freely in its bearings and the casing is free to turn in its bearings, except as it is held in place by the device for measuring torque.

Water is supplied by a pipe which comes up through the floor in Fig. 1 and branches to both ends of the casing, as shown in Fig. 3. The water passes from the ends of the casing through the slots between the fixed cups, as shown in the cylindrical section, then into the cups of the rotor and is thrown back and forth between the moving and fixed cups and escapes at the outside of the casing near the middle. The water is delivered by the pipe shown in Fig. 1, running up over the branched inlet pipe and then turning down. The inlet pipe has sufficient flexibility to allow freedom of motion to the casing; the outlet pipe delivers through an open end into a tunnel.

The shaft in Fig. 2 has plain bearings and the casing has anti-friction bearings that are not well shown. Fig. 3 shows the machine equipped with ball bearings.

The casing is prevented from rotating, as shown in Fig. 1, by an open frame which carries a scale pan for receiving weights at the end of the long arm. There is a sliding weight for finer adjustments. There is a dash pot to check irregular movements and a counterbalance weight on a short arm beyond the shaft.

All the frictional resistance of the shaft in the glands and of the shaft in its bearings is applied immediately to the casing and is measured as torque, together with the torque due to churning the water. There remains unaccounted for only the friction of the casing on the pedestals, and this develops only a negligible amount of work because the casing, while free in its bearings, is held in place by the frame and its weights. Consequently the Froude dynamometer gives an accurate and correct determination of the power received from the motor. The weight of the shaft, rotor and casing is all carried by the dynamometer itself and there is no load to transfer back to the engine bearings.

There are three elements that enter into the computation of power: (1) The length of the arm carrying the weights measured from the axis of the shaft, which is determined by the construction of the machines; (2) the weights hung on the pan; (3) the revolutions of the shaft, this last being determined by aid of a counter driven by the shaft.

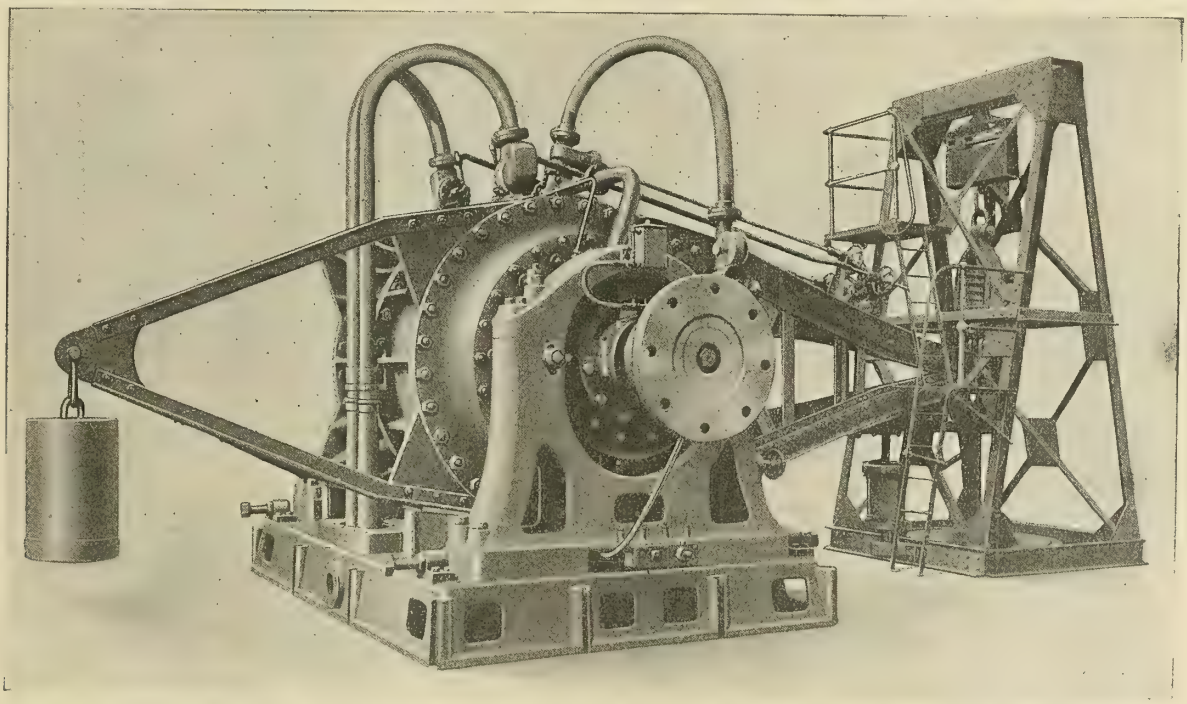


Fig. 4.—Froude Reversible Low Speed Dynamometer, with Rated Maximum Capacity of 4,000 Brake-Horsepower at Speeds of From 125 to 180 Revolutions Per Minute

Let W be the weight in pounds, R the revolutions per minute, and L the length of the arm in feet. Then the brake horsepower is computed by the formula

$$B.H.P. = \frac{2\pi L \times W \times R}{33{,}000} = \frac{WR}{K},$$

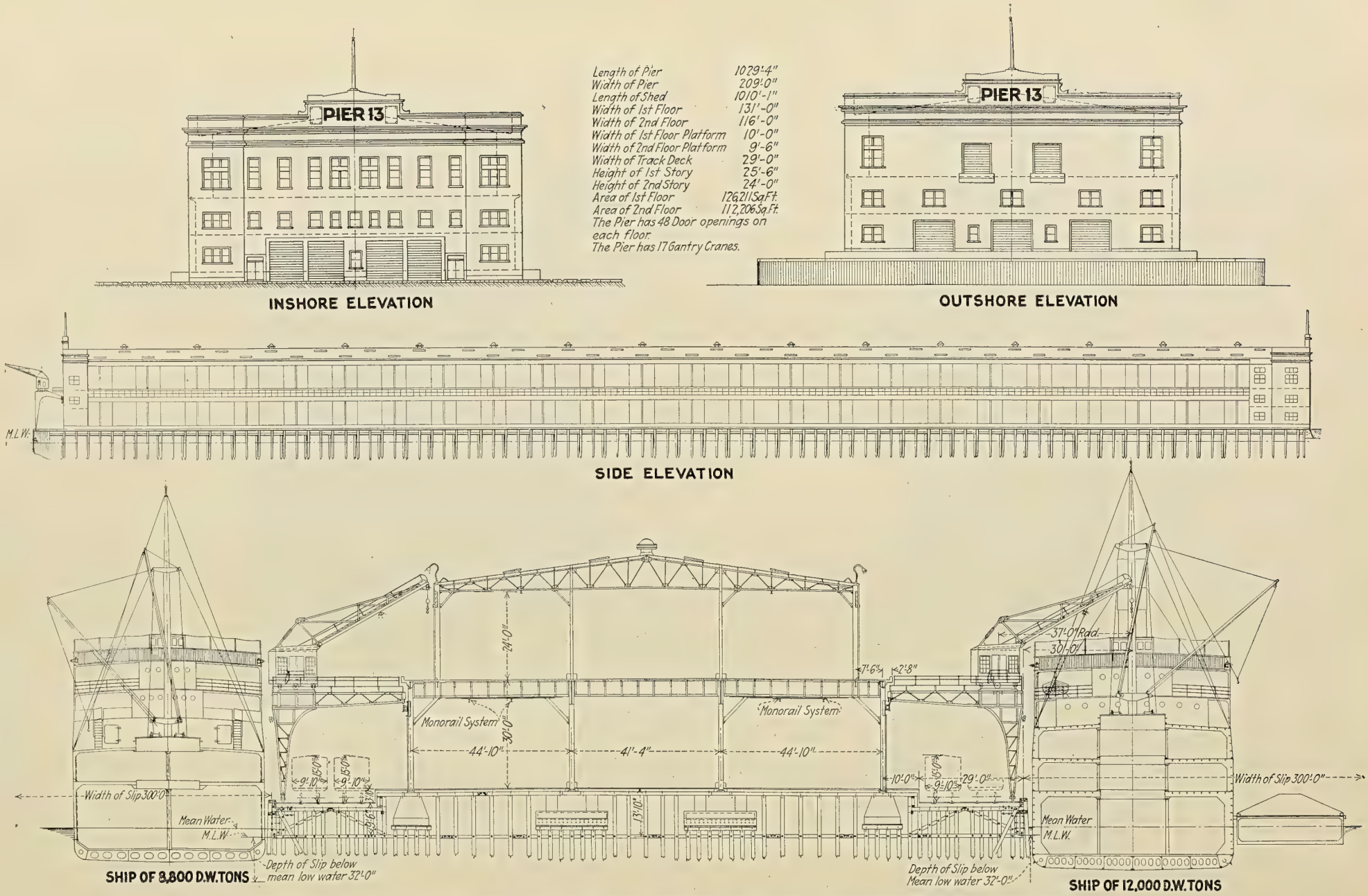


Fig. 1.—General Arrangement of New Staten Island Pier, With Two-Story Shed and Mechanical Freight-Handling Equipment

where K is the machine constant supplied by the makers.

The dynamometers considered are single acting and can be driven only one way, though they can be adapted to either right or left handed rotation. Fig. 4 shows a dynamometer of 4,000 horsepower that can run in either direction arranged so that the torque is determined by a weighing machine.

The load imposed by the dynamometer is determined by the amount of water passed through the machine. The larger amount of water there is passed back and forth between the caps of the rotor and the casing, the greater the power absorbed. In order to get a steady load, it is important that the water pressure supplying the dynamometer should be steady. The readiest way to obtain this result is to have the supply come from a special open tank which may be filled automatically from the general water supply. This is particularly important at reduced powers because an interruption or a sudden reduction of the water supply may make the dynamometer jump or even allow the engine to run away. Engineers using the hydraulic dynamometer should determine whether and under what circumstances there may be danger of jumping and avoid approaching a dangerous limit.

The Froude dynamometer is made in various standard sizes suitable for testing motors of all sorts, from automobile and airplane engines up to marine and stationary engines of 6,000 horsepower. There are also made machines for running in various motors under full or reduced loads. Such brakes are not supplied with measuring devices, but each machine is supplied with an approximate capacity curve so that it may be adapted to any desired operation.

The New Piers at Staten Island

General Arrangement and Equipment of Twelve New Piers to be Added to the Terminal Facilities of New York Harbor

BY FLOYD T. SMITH*

NEW YORK City will soon have twelve more piers. Work has already been started and some of the construction is well under way. Considerable has been written about the apparent disregard of present-day practice in terminal design of these piers and the lack of proper forethought in planning for the future, thereby suitably providing for the rapidly increasing trade and furnishing adequate equipment for handling the growing export business. It is a keen disappointment to many that the great Port of New York, with its enormous amount of shipping, can not boast of the finest piers in the world and point with pride to this terminal as a complete unit, as one that is the last word in design, modern in wide pier construction with adequate warehouse and shed capacity, with rail connections and supplied with the latest freight-handling equipment as a means of insuring a ship's quick turn around.

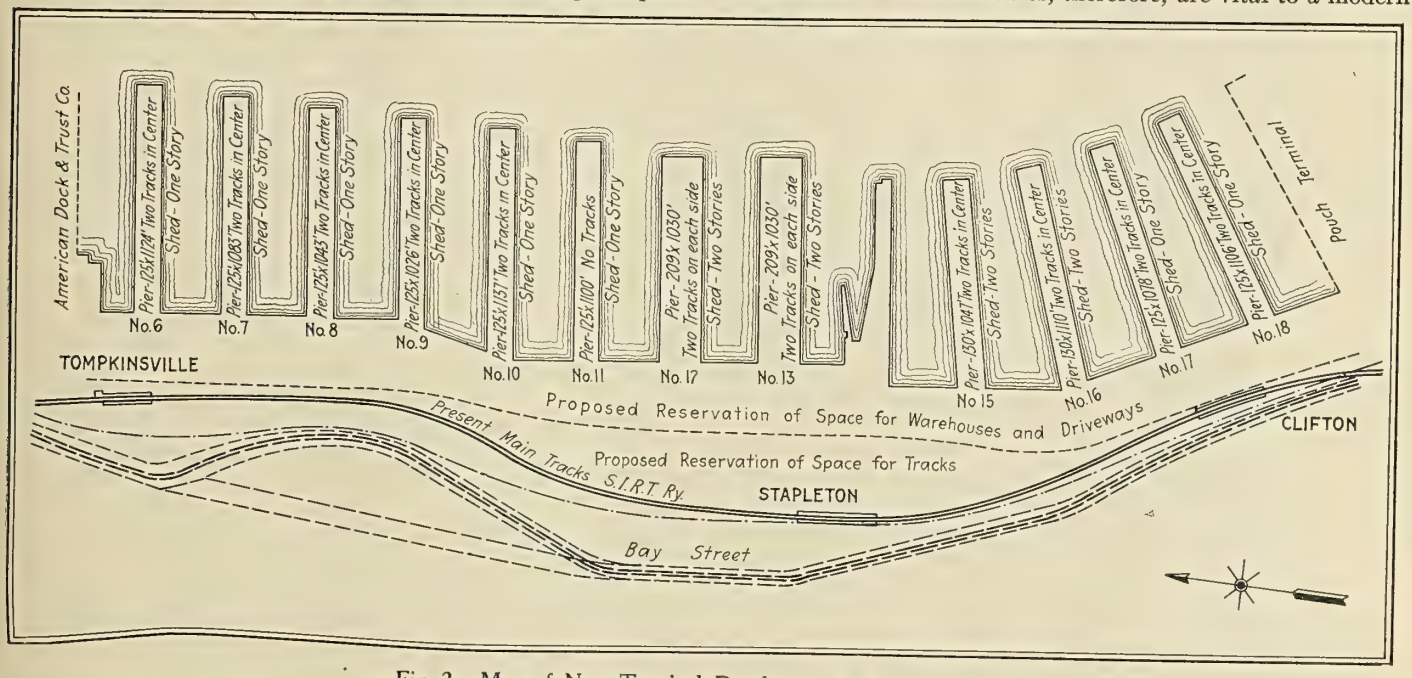


Fig 2.—Map of New Terminal Development on Staten Island

The marine terminal is naturally an outlet to the sea for the railroads and generally the railroads are necessary and attendant to it. The supply of commodities throughout the country demands an outlet and the imports require a receiving point for distribution inland. Unloading and loading imports and exports are very different. The two are very much unlike. What features, therefore, are vital to a modern terminal? They might be outlined as follows: Location, rail connection, commodity handled, type of construction and handling equipment installed.

ADVANTAGES OF NEW STATEN ISLAND PIERS

The piers at Staten Island will have many natural advantages. They will have the advantage of being located somewhat nearer the ocean than the present piers on Manhattan and the piers immediately adjacent to it. They will be situated on the north side of Staten Island, just inside the Narrows and facing New York. They are on the west

* Power and Mining Department, General Electric Company, Schenectady, N. Y.

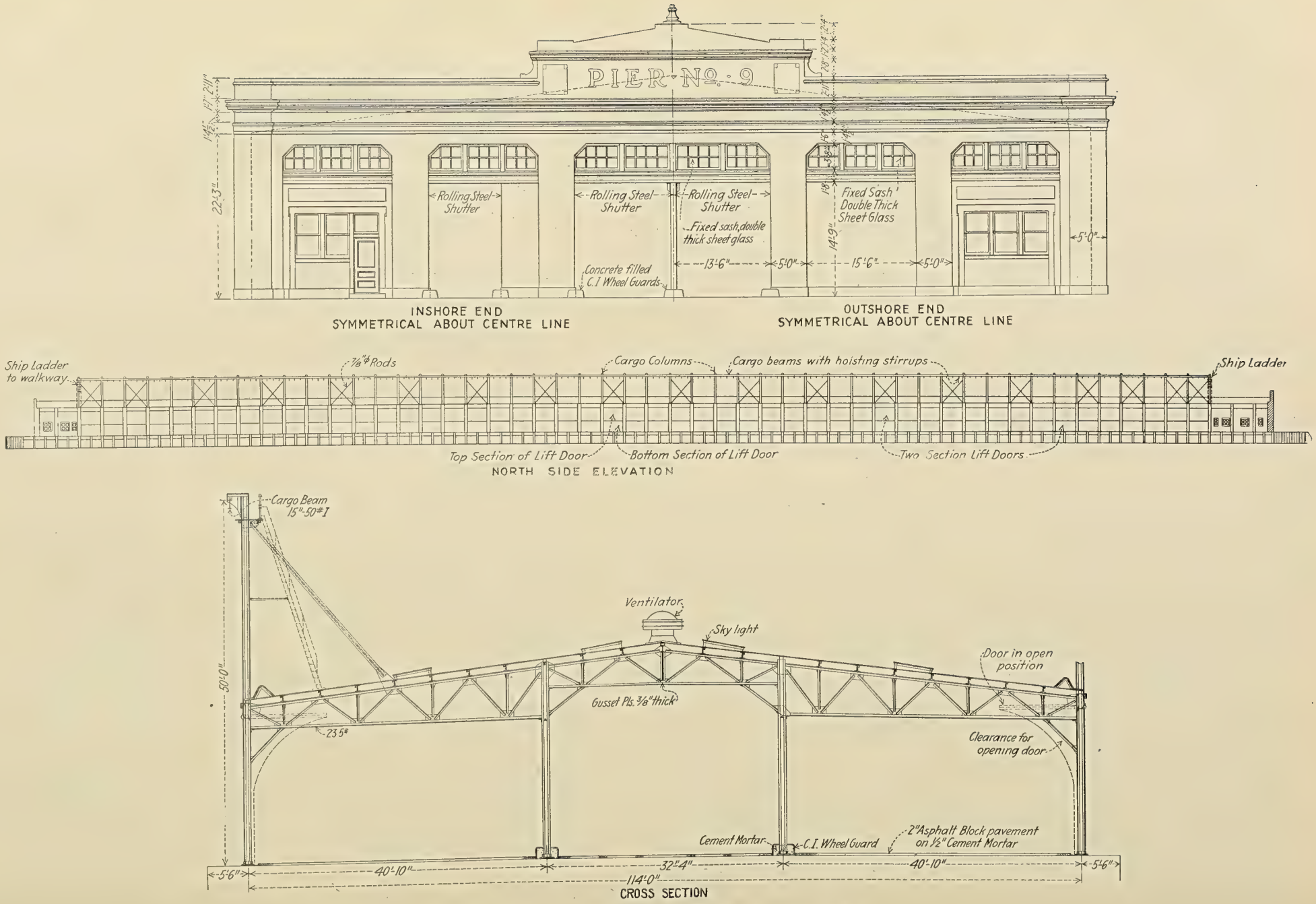


Fig. 3.—Sections and Elevations of Pier With One-Story Shed

side of the river, adjacent to the mainland, thus saving extra transfer of the majority of freight by lighter. They have the advantage also of direct rail connection which was not possible except in a more or less indirect way with the present piers on Manhattan.

The piers will be connected by rail with the Baltimore and Ohio Railroad, and it is expected that proper track layout will be made furnishing an enlarged railroad yard and in turn connecting with the tracks on the piers. It is possible and a very great advantage to make connections with a trunk railroad line crossing New Jersey. Such connections can be made not only with one trunk railroad but with all of the following: Pennsylvania, Reading, Central of New Jersey, Erie, Delaware and Lackawanna, Lehigh Valley and West Shore. This would give a very important and valuable rail connection with every part of the country.

Comparison With Terminals at Other Ports

A comparison of the Staten Island piers with the largest terminals at other ports shows the following: At Staten Island—two piers 209 feet wide and 1,330 feet long; two 130 feet wide and approximately 1,047 feet and 1,110 feet long; eight 125 feet wide and 1,026 to 1,130 feet long; at Seattle, Smith's Cove Terminal—Pier A 2,530 feet long and 310 feet wide; Pier B 2,580 feet long and 367 feet wide: Portland, Oregon, pier 1,350 feet long and 480 feet wide; Boston, 1,200 feet long, 400 feet wide; Montreal, 1,250 feet long, 300 feet wide; Philadelphia, 1,200 feet long, 300 feet wide; San Francisco, 981 feet long, 200 feet wide; Baltimore, 1,450 feet long, 200 feet wide.

General Arrangement

Two piers will have two railroad tracks on each side of the piers; one pier will be built without provision for tracks and eight piers will have two tracks in the center. The railroad tracks will be depressed so that the floor of the shed will be on the same level with floor of cars, which greatly facilitates the handling of freight.

Four of the piers will have two-story pier sheds and the others will have sheds of one-story construction. However, three forms of construction will be adopted, i. e., the single-story shed, a double-story shed and a double-story shed with provision for crane equipment.

Two piers will have cargo crane equipment. The pier sheds not provided with cranes and provision for a loading platform around the second floor of the shed will have the familiar cargo masts and will be furnished with two-ton winches that will be conveniently placed so as to be used in connection with the cargo masts for rapid unloading.

The slips will be uniform in size, 300 feet wide, which allows two ships with a lighter alongside of each to berth and still have a passage way between for a lighter.

The piers and pier sheds will be well supported by warehouses at the shore end and these warehouses, as well as the two-story pier sheds, will be provided with elevators.

One pier to be occupied by the International Mercantile Marine will not be furnished with equipment, not even railroad tracks. And while this is not an indication in any sense that this is proper pier construction, yet it would be expected that with its many years' experience in cargo handling, such a concern would naturally use advanced methods or perhaps adopt means somewhat ahead of present-day practice, rather than ignore the results the use of mechanical apparatus will accomplish.

It may be said, however, that the new cargo ships are generally provided with winches, which is one reason why no extensive mechanical equipment is to be provided on most of the piers which will nevertheless be furnished with cargo masts designed to operate in conjunction with a ship's cargo handling equipment.

The principal points of disagreement of the type of construction adopted for the several piers are: narrowness of the piers, failure to provide track facilities on the piers and lack of cargo handling machines. Favorable and unfavorable comments have been made for both forms of construction but the wider pier which provides means for storage and releases railroad cars for other service seems the one more universally adopted. Furthermore, if direct loading and unloading is to be done, two tracks at the sides and the cranes spanning them, allow the cars to be run to the ship's side, which gives an interchange of cars loaded and unloaded and permits ready and quick unloading from the ship to car and vice versa.

Piers Leased by Pan-American Terminal and Dock Company

Of a total of twelve freight piers to be erected by the city the two leased by the Pan-American Terminal and Dock Company are notable exceptions. It is proposed to have installed on them the most modern freight handling machinery such as revolving cranes outside the sheds and monorail hoists or traveling cranes inside the shed, together with elevators. There will be two 20-ton truck elevators and two 10-ton freight elevators.

It is proposed to install 17 electrically operated wharf semi-portal cranes located on each pier of design as shown in Fig. 1. The capacity of the cranes will be approximately 5,600 pounds on the hook, with a hoisting speed of 125 feet per minute. Each crane will be fitted with a cable on a self-winding reel and a controller for the use of magnets when handling iron. The cargo will be taken from the ship's hold and delivered to the first and second floors of the pier shed. In loading the cargo is taken from either the first or second floors and delivered to the ship.

It is estimated that a crane should be able to make 40 full operations per hour, which with an average load of 2,500 pounds would move about 44½ gross tons of cargo, and for a ship with four hatches would give 178 tons per hour or 1,424 tons per day of eight hours. Each pier is to accommodate 4 of the 10,000-ton standard ships at one time and besides this there is ample space for several lighters and barges. This would indicate a turn around of about 34,000 tons of cargo per week of 6 days, but on account of lost time in shifting ships, the estimated turn around for each pier should be about 25,000 tons per week. The amount of cargo being loaded or discharged will be about the same. About 60 percent of this will be handled from the first floor and railroad cars while the remaining 40 percent will be handled from the second floor.

The total area of one pier is about 242,000 square feet with about 161,000 square feet available for storage of cargo and when the same is piled to an average height of 12 feet there will be space for about 49,000 tons of 40 cubic feet per pier.

The cargo will be handled inside the pier shed by overhead monorail hoists of which there will be approximately 20 on each pier. The capacity of the monorail hoists will be approximately 5,600 pounds on the hook with a hoisting speed of 70 feet per minute ,and a travel speed of 350 feet per minute.

It is estimated that each of the monorail hoists should be able to make about 32 full operations per hour, which speed should insure handling of the same amount of cargo inside the shed as the cranes are able to handle outside the shed.

Eight Piers Leased to Date

The readiness with which the piers have been leased shows that, although they are more than 10 miles from New York City hotels and shipping districts near where passenger lines

always had docking faculties, this distance will not prove a disadvantage.

The following companies have made definite arrangements to use these piers and have signed leases for a number of years:

Pier No. 6.—Green Star Steamship Company.
Pier No. 8.—Wesel Deval & Company.
Pier No. 9.—Moore and McCormack.
Pier No. 10.—Raporel Steamship Line.
Pier No. 11.—International Mercantile Marine.
Pier Nos. 12 and 13.—Pan-American Terminal and Dock Corporation.
Pier Nos. 15 and 16.—Union Transport Company.
Pier No. 17.—Compagnie Generale Transatlantique.

Mechanical Handling vs. Old Method

Some hesitate to believe the results that have been accomplished at many of the modern ports in which mechanical equipment has been installed. As an illustration of what can be done by developing the use of mechanical equipment a comparison of two cargoes handled in the last few months at Smith's Cove Terminal in Seattle, one of the largest and most modern of the newer terminals, is of interest.

On March 13, in a cargo from the *Mandansan Maru*, there were 2,398 tons or 11,937 barrels of oil. The cost of handling and stacking this barrelled oil two tiers high on the pier was 45 cents a ton or 9 cents per barrel, the cargo being handled by the old method of hand truck and piling.

On June 13, with the use of mechanical equipment there was unloaded from the *City of Spokane,* 1,730 tons of barrelled oil or 8,612 barrels. The cost was reduced to 33 cents per ton or 6.6 cents a barrel and the barrels were piled three tiers high.

Taking the same vessels unloading dry cargo; on March 13 there were unloaded from the *Mandansan Maru* 1,000 tons of beans, rape seed and maize at a cost of 39 cents per ton. This material was handled by two wheeled trucks.

On June 13 there was unloaded from the *City of Spokane,* 3,000 tons of bean cake and sugar, handled by tractors, trailers and loading platforms at a cost of 20 cents per ton, a saving of practically 100 percent on dry cargo. This is just an indication of what the future holds on reducing cost of handling freight by means of mechanical equipment.

The mechanical equipment contemplated for inside the pier shed on the Staten Island piers, such as industrial storage battery trucks and tractors, mechanical piling machines and portable conveyors, remains a conjecture, but it is fair to assume that with results in mind that have been accomplished elsewhere the operating companies, profiting by experience and fully aware of the surprising results that can be accomplished, will use modern equipment.

It has been stated that in assuming the approximate cost for the 125-foot one-story pier as 100 percent, the approximate cost of the 209-foot two-story pier with the mechanical equipment will be 251 percent, showing a difference of 151 percent. It is naturally expected that this increased cost will be more than justified by the rapid loading, gain in earning power and more rapid ship turn around.

Unfortunately, the construction of the piers and pier sheds that will not use the overhead traveling cranes or monorails inside the sheds is such that should later events demand more adequate methods of handling the structure will not support it.

Whether the form of construction adopted is a wise move, the future will confirm or disapprove.

Current Shipping Board Expenditures Will Influence Our Future Merchant Marine Policy

(*Continued from page* 233.)

vessels on the active list, there was a suggestion that it might be the proper course to tie up the entire fleet forthwith. Shipping Board officials have opposed this as unwise and to an extent impracticable. For one thing it has been pointed out that the expense of tying up the fleet would run, according to estimate, in the neighborhood of $8,000,000 a year. Furthermore, a number of the ships are at foreign ports or on distant trade routes and would have to be returned to United States ports in any event. Shipping Board executives, in conference with the leaders of Congress, have urged that the preferable policy is for the government to, for the time being, take its losses, just as private vessel owners are doing and stand ready to recoup when commerce revives. The opinion in this quarter, quoted for what it is worth, is that shipping conditions will be back to normal in six or eight months.

It is the disclosures as to current losses in the operation of Shipping Board vessels that has been responsible, more than anything else, for the development of the existing tense situation between Congress and the Board, with respect to the policy on uncompleted contracts for vessel construction. Restless, in the face of a ship operation deficit running close to $50,000,000 a year, the leaders of Congress have been visibly irritated by the disclosure that Commander R. D. Gatewood, director of construction and repairs of the Shipping Board, sent, as of comparatively recent date, communications to shipbuilders holding government contracts urging them to expedite the work in hand. It did not help matters that Commander Gatewood explained that it was his idea to speed up construction in order that the entire building programme might be completed so far as possible prior to the beginning of the new fiscal year on July 1, 1921.

Completion of Vessels Under Construction

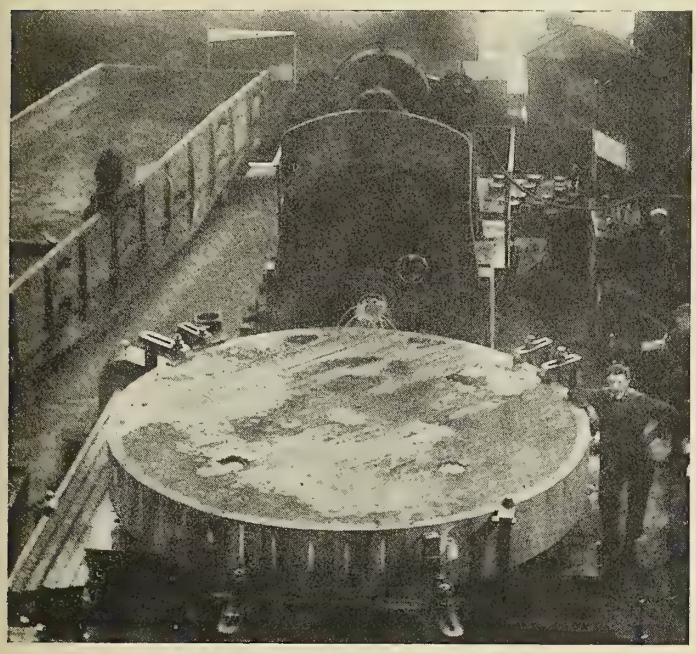
In the discussions that have continued at the Capitol since the middle of January, the Shipping Board has, in effect, been continually on the defensive for its policy of sustained vessel construction. Shipping Board executives stick to their guns with the defense that regardless of whether or not the government needs or wants more ships, it is more economical to complete the vessels now at the shipyards than to make cancellations. On this point Commander Gatewood recently declared: "Almost all the material for these ships has already been purchased and most of it paid for and is in the yards of the contractors, taking up valuable storage space, and the material ought to be put into ships so we can get rid of the heavy overhead of construction and get the ships either laid up or into service.

"The programme has been strung out too long now. Some contractors in their desire to reduce their forces after the armistice, which was a very warranted desire and a very worthy desire, in some cases reduced too much and in other cases they shifted their forces over to some more profitable private work, thus leaving our programme to suffer in spots. I want to say that these vessels ought not to be stopped because if they are stopped it will result in a very heavy loss. Stopping the ships on this programme for even a day will cost around $150,000 per day. If the programme is allowed to go ahead, it can be finished up and we will be taking advantage of the increased efficiency of labor and of any wage drop that may occur. We can get rid of the overhead on construction and our own overhead in that way and make more money by going ahead than we could by stopping at this time."

The World's Largest Gyroscope

THIRTY years ago gyroscopes were looked upon only as mystifying toys for the children or by scientists as a means of displaying or developing their knowledge of higher mathematics when theorizing on gyroscopic laws and reaction.

Then gyroscopes never "grew" more than a few inches in diameter. But about this time Mr. Elmer A. Sperry, a scientist of renown in many branches of engineering, set himself to employ the interesting peregrinations of the gyroscope to some good uses. So successful have been his efforts that already over one thousand of the world's naval vessels, and during the last year upwards of one hundred merchant ships, have been equipped with the gyro compass. The earth's rotation is thus employed for navigation, the little gyros giving a powerful and accurate true north indication.



Machining 90,000-Pound Gyro Rotor

A newer and more interesting application to the traveling public is in the use of the gyroscope as a stabilizer to prevent a vessel's roll. Some twenty odd equipments have already been put in service and we take pleasure in showing here, in the process of machining, the largest gyroscope yet built. The picture was taken in the Nicetown Works of the Midvale Steel & Ordnance Company, where the huge forging, weighing over 90,000 pounds was made. When finished machined, with heavy rim, solid web and hubs for shaft stubs, this rotor, or gyroscope, will be 12½ feet in diameter and weigh 70,000 pounds, or 35 tons. Two of these rotors will be bolted together. This mass, weighing approximately 75 tons, running at 850 revolutions per minute, will stabilize a 10,000-ton cruiser enabling her to enter an engagement in any weather with level gun platforms.

A further point of interest is that, due to the omission of bilge keels and the power saving brought about by the elimination of roll and the reduction in the yawing and wallowing, the stabilizer will save several times the power required to run the gyroscope. This will enable her to use less fuel when maneuvering in smooth seas or maintain nearly the same speed in rough weather.

A 1,100-ton yacht, the *Lyndonia,* has just completed a passage to Charleston where the roll was easily quenched from 18 degrees to 3½ degrees when the stabilizer was turned on.

A number of other stabilizers are now in the process of manufacture, including equipments for various size vessels, from an 800-ton yacht to an 18,000-ton passenger liner.

The efforts of Mr. Sperry and his corps of engineers are thus reaping early results and shipping men throughout the world are looking forward, with keen anticipation, to the opportunity of observing a large passenger liner freed from roll and made independent of the elements.

Membership Campaign Under Way for the Society of Marine Draftsmen

IN order to excel on the sea and as a shipbuilding nation, the United States must have the best ship designers. Through co-operation the efficiency of American ship designers can be materially increased and it is for this purpose that the American Society of Marine Draftsmen is now entering upon an active campaign for the increase of its membership. Marine draftsmen must have up-to-date knowledge of all the latest marine appliances; they must know the best and most economical methods of design and understand their application. To acquire this knowledge, and to qualify for advancement in the profession, no better medium is offered than the American Society of Marine Draftsmen with its lectures, general discussions and its journal.

Grades of Membership

Four grades of membership are available in the society, designated as members, associate members, associates and juniors. A member must be a draftsman at least twenty-five years old, who has had at least seven years' experience as a marine draftsman and, at the time of making application, shall be actively engaged in marine or naval work. He must be of such character and standing professionally and otherwise as will promote a high standard of membership. This grade covers all draftsmen, chief draftsmen, naval architects, engineers, production managers, superintendents and men engaged in shipbuilding who can qualify by previous experience.

An associate member must be a draftsman at least twenty-one years old, who has had four years' experience in drafting and is engaged in marine or naval work but is not eligible to a higher grade of membership.

The grade of associate, which was established at the society's last annual convention, is designed to include men who are engaged in the manufacture and selling of marine equipment. An associate must be at least twenty-one years old and hold an executive position in the selling or manufacturing of marine equipment or in the operation of ships.

A junior must be a student in a recognized regular engineering or naval college or a draftsman actively engaged in marine or naval work. He must be at least eighteen years of age, but not eligible to a higher grade of membership.

Where to Apply

Application blanks for membership or any further information regarding the activities of the society can be obtained from any of the following:

Morris L. Potts, chairman, 1741 North 62d Street, Philadelphia, Pa.

R. R. Doerflinger, 65 Layton Ave., New Brighton, S. I., N. Y.

H. J. Thiede, 7411 Rising Sun Ave., Philadelphia, Pa.

M. M. Blunt, 13 Edmands Street, Winter Hill, 45, Mass.

A. D. Micotti, 312 Copley Courts Apt., Washington, D. C.

J. N. Miller, Newport News Shipbuilding & Dry Dock Company, Newport News, Va.

F. S. Dubois, P. O. Box 98, New London, Conn.

J. N. Taylor, 305 Washington Street, Bath, Me.

W. H. Walker, 46 Eagle Street, Bridgeport, Conn.

J. H. Holmes, P. O. Box 162, Bethlehem, Pa.

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WE GUARANTEE, that of this issue 8,100 copies were printed; that of these 8,100 copies 6,486 were mailed to regular paid subscribers, 360 were provided for counter and news company sales, 331 were mailed to advertisers; 79 were mailed to employees and correspondents and 844 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 25,800, an average of 8,600 copies a month.

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Subsidy

EVEN as our farmers and manufacturers must be protected by a tariff, which is no more and no less than an indirect subsidy, so must our shipping receive some sort of government aid. Fortunately, any subsidy that is given to shipping immediately places a premium on vessels built in American shipyards because the war time act which allowed the Shipping Board to grant the privileges of the American registry to foreign-built vessels has been repealed. American shipping and shipbuilding will, therefore, live or die together; and, as it is ridiculous to expect the men engaged in shipping and shipbuilding to accept a foreign standard of wages or living, the difference must be made up in some way or another.

It is all very well for us to be proud of American ingenuity and the success that we have had in the quantity production of sewing machines, automobiles, harvesting machines, etc., but a ship is not a machine; it must be erected like a building, and the amount of hand labor will always be very large. And, whatever may be the case in other industries, it is certain that the greater part of our shipbuilding talent learned their trade or profession in a foreign country. One of our leading shipbuilders has recently stated that the cost of a vessel is divided as follows; 40 percent for labor, 40 percent for material and 20 percent for overhead. Although some materials are cheaper in this country, the cost of labor is at least twice as much as it is abroad, which is a handicap that no sane shipbuilder can hope to overcome.

The first cost of a vessel is the sum upon which the ship operator must figure his fixed charges. These include insurance, depreciation and interest, a total annual charge of about 15 percent of the original investment. Comparing the present price which the Shipping Board is asking for its vessels with the market price abroad, these three items alone in the case of an 8,800-ton cargo vessel, for example, would make an annual difference in favor of a similar foreign vessel of over $100,000. It is the fixed charges rather than the wages of the sailors which constitute the greatest obstacle that the shipowner has to overcome.

Captain Paul Foley, director of operations for the Shipping Board, states that the running expenses for operating vessels is divided as follows: fuel, 43 percent; repairs, 30 percent; wages, 15 percent; deck and engine room stores, 6 or 7 percent; subsistence, 4 or 5 percent. While the wages are undoubtedly greater on American vessels than on foreign ships, it is quite possible for an intelligent American crew to more than make up this difference in the items of fuel and repairs. At any rate, the difference in wages and the eight-hour day with overtime are the result of the demands of the unions rather than the requirements of the Seaman's Act.

No doubt our navigation laws can be improved, but they are nowhere nearly as bad as they are painted, and it is foolish for us to talk of new laws until we enforce the constructive features of the laws that we have. American shipowners have the right to expect the benefits of the discriminatory custom duties imposed on imports carried in foreign vessels and the discriminatory tonnage duties on foreign vessels as provided for in the Merchant Marine Act of 1920, or *an equivalent direct subsidy*. The fact that, after our first Congress had imposed similar duties, we increased the amount of commerce carried in American vessels from 24 to 89 percent in the short time of ten years indicates how effective such a subsidy would be. But, as we have neglected to give notice to foreign governments that we intend to impose these duties and as diplomatic negotiations, particularly at this time, must be slow, it is the duty of Congress to grant an equivalent direct subsidy until the Merchant Marine Act can be enforced.

Sale of Shipping Board Vessels

EXPERIENCED shipowners appear to be of one mind in regard to several features of our future marine policy, namely, that the United States should have an adequate merchant marine, that the vessels should be owned and operated by private interests, that the Government should not allocate vessels to operators to engage in unrestricted competition with established shipowners, and that for a considerable time to come the Government cannot sell its ships at any price. The first three features ought to be self-evident. The only question about them is, are the policies to which they relate receiving our active support or is their adoption assumed as a matter of course?

While we are not prepared to admit that the Shipping Board cannot dispose of its vessels at, say, the average book value of English ships, it is certain that it cannot sell these vessels at anywhere near the price it would cost to rebuild them in American shipyards. This will probably continue to be the case until a definite shipping policy is adopted and, further, it must be such a policy that capital will be reasonably assured that it can operate the ships at a profit on the cost price. In view of the present business depression, it is perhaps just as well that the Government did not sell its ships even at a reduced price, as a large number of failures have thereby been averted. Again, no reasonable price can be placed on an American vessel until it is known whether

the Government is going to enforce the discriminatory features of the Merchant Marine Act, grant an equivalent direct subsidy or compel our shipowners to run our merchant marine with foreign crews on a foreign standard of wages.

The Foreign Trade Financing Corporation

THE formation of The Foreign Trade Financing Corporation under the provisions of the Edge amendment to the Federal Reserve Act, for the purpose of providing long term credits to purchasers of American goods, promises to afford to Europe, Asia, Africa and South America the opportunity to purchase the raw materials and manufactured products that they need on a straight business basis.

As the law provides that such corporations may issue bonds and assume liabilities up to ten times their capital stock, this $100,000,000 corporation can handle business up to the value of $1,000,000,000. The welfare of the country demands the development of our foreign trade because we are now producing raw materials and manufactured goods far in excess of our wants and the rest of the world needs our surplus badly. Many of our ships now lying idle will be needed to transport these products to the ports of the world and bring back goods in return.

Corporations of this sort can not entirely solve the problem of making a foreign market for our products. Serious consideration must be given to what effect a high protective tariff would have on countries that are disposed to buy our products. We can, of course, artificially raise the prices for the producer in the home market, but it is evident that we cannot sell to other countries, if the prices established by ourselves are materially higher than the general world prices based on the law of supply and demand.

America Not Over-Supplied With Ships

THE United States is still carrying less than 50 percent of its imports and exports in its own ships, the figures furnished by the Shipping Board for 1920 being 42.7 percent in American and 57.3 percent in foreign bottoms. As only a very small percentage of American vessels are engaged as feeders or assigned exclusively to routes between foreign ports, these figures show that our ocean-going tonnage, in spite of its great recent growth, is by no means too large for the requirements of our country, which should rightfully carry somewhat more, rather than somewhat less, than fifty percent of its overseas commerce.

Although the employment situation in this country demands the marketing of our surplus raw and manufactured products in foreign countries, although large financial corporations are being formed to extend long-term credits and help foreign buyers to purchase our products and although Section 28 of the Merchant Marine Act provides for the extension of preferential rail rates to goods carried in American bottoms, we are continually tying up our ships and releasing the crews recently trained in seamanship to engage in any occupation that they can get.

We all realize that an American merchant marine is necessary to the successful development of our foreign trade, and that the buying power in our domestic market is seriously affected by the accumulation of surplus products, yet we continue to deny to shipping even a small percentage of the protection that made possible the wonderful development of our manufacturing industry. The Shipping Board has collected accurate comparative data on the costs of shipbuilding and ship operating in this and other countries, and it ought not to take the new administration long to decide that shipping needs either a direct or indirect subsidy. If the new administration and the new Congress represent the will of the people they will grant the ship operators sufficient aid to compete with foreign countries on an equal basis and, then, it can be safely left to American ship operators to get their share of the commerce, which means still more ships.

Manning Requirements

THE number of extra men that must be carried on American as compared with foreign vessels has been repeatedly advanced as one of the principal handicaps working against the successful operation of our merchant marine. The number of the crew will, of course, depend upon the type and size of the vessel and no general percentage of the number of extra men can be given, but taking a specific example, the crew lists of 8,000-ton deadweight coal burning cargo boats under American and foreign flags are about as follows: American, 48; British, 45; Norwegian, 40; Japanese, 59. In this type of boat we require three more men than the British, eight more men than the Norwegians, and eleven less men than the Japanese.

The significant feature in the above comparison is the fact that the Japanese ship has by far the largest crew, but as their wage scale is very low, the total cost of the crew is much less than that of any other country. The Japanese, however, are noted for the minimum amount of repair work that their ships require in foreign ports. While it will probably be impossible to induce American seamen to accept the British standard of wages, we can reasonably expect a great deal more of our repair work to be handled on shipboard.

The Essentials of a Battleship

A BATTLESHIP is subject to four forms of attack—gun fire, torpedoes, bombs from aircraft, and mines. Mine fields are anchored and capital ships are not sent over them. If by inadvertence a ship strikes a mine, whether anchored or adrift, the ship cannot expect to escape; a good subdivision improves the chance, but no ship can be so designed as to resist mines and remain in action. Bombs from aircraft, if they strike a ship, may destroy the superstructure and perhaps do serious damage, but 217 bombs dropped by airplanes in an attack on the *Goeben* did not destroy her, though she lay aground for a week. Many ships, especially of older classes, were destroyed by torpedoes during the war, but no important action was determined by torpedo attack. The principal effect was deterrent, both sides being shy of maneuvers which would give a chance for torpedoes. The destroyer, though developed from the torpedo boat, is now a scout more likely to use guns than torpedoes. The attack to which a battleship in regular service is most exposed is gun fire—and gun fire is now tremendously more powerful than ever before.

The essential characteristics of a battleship are a powerful battery and good armor protection; it can strike hard and stand punishment. A compact squadron of ships having

these characteristics need not fear attack from any combination lacking them. Speed is valuable for maneuvering and is more valuable in proportion as maneuvering enters into a battle at sea. The larger the fleet the greater the chances and need for maneuvering.

Recent battleships have the essentials pre-eminently. There is no question of the sufficiency of a battery of twelve 16-inch guns. As for armor, it is to be remembered that the *Warspite* remained in the line after receiving twenty heavy shells. The battle cruiser has shown greater resistance than could be expected. In the battle of Jutland twelve battle cruisers were hit 150 times; on the other hand, three British battle cruisers vanished from the field of battle. Battle cruisers building for the United States have been redesigned with greater protection. There yet remains a question whether they are fit to lie in the line.

The Sea Habit

"CATCH them young, dip them in tar, and they never know the difference." Such was said by an admiral of the old school to be the method of recruiting the officers of the British navy. Story and song tell of the midshipmite, and finally a grave question was asked in Parliament whether the securing of the British Empire depended on sending children to sea. They still catch them young, but they send them to school; whether they will continue the old breed of sea dogs remains to be seen.

Our own method takes young men of sixteen to eighteen—about the college age—and keeps them at the Academy for four years. Truly, they have summer cruises, but the sea habit must be attained after they are old enough to vote, and the sea habit is not for everyone to attain. The reputation of the officers of the American navy needs no defence, and a method which has stood the test of time is not lightly to be criticised; but the best method that can be devised is none too good for a navy such as ours is and is going to be. Cannot some method be devised by which the sea habit may be attained young?

Determination of Brake Horsepower

WITH the advent of the steam turbine and the internal combustion engine, means for measuring shaft or brake horsepower became imperative. The stationary steam turbine has been most widely used at electric power stations and the output of the electric generator and its efficiency gave a ready way of determining the input; the input is appreciably equal to the turbine shaft horsepower. For other purposes the turbine power can be inferred from similar turbines which drive electric generators. On shipboard various forms of shaft dynamometers have been applied, which serve their purpose, though none is entirely satisfactory.

Small steam engines and other motors have had friction brakes applied to determine the shaft horsepower and the mechanical efficiency. Commonly such brakes have been improvised or, at any rate, cheapness has dominated the construction. Up to ten horsepower any decent rig will work after a fashion and the brake may run without cooling water, at least for short periods. But when large powers are to be absorbed the brake must be well designed, soundly built and must have an efficient water cooling system. Such a brake is likely to be bulky and costly, but may be made to run steadily under full load for any length of time and will give accurate and reliable results. The Alden brake of special construction has been made to absorb several hundred horsepower.

If any motor can be adapted to driving an electric generator, its brake or shaft horsepower can readily be inferred from electrical measurements of the generator. But this requires certain standardization of the motor and usually demands the attention of an electrical engineer. Electrical engineers commonly use a cradle dynamometer, made by hanging a generator on an axis and preventing its motion by a brake arm and weights. Such a device is an electric brake, and power is computed as for a friction brake from the length of arm, load on the arm and the number of revolutions. Large cradle dynamometers are expensive and inconvenient in use.

The Froude hydraulic dynamometer described in another column of this magazine appears to fill all the requirements for the ready determination of shaft horsepower and is now made in all sizes up to 6,000 horsepower. It is compact and powerful and is not unduly expensive.

The Naval Engineer

ANY military organization is essentially aristocratic, and aristocracy is naturally snobbish, and snobbery never accomplished anything except making somebody unhappy and interfering with his usefulness.

Our navy was fortunate in that the first engineer commissioned was a gentleman with acknowledged character and reputation. He was the equal of any line officer and would accept a commission on no other terms. He did more unconsciously for the morale of our navy than all his recorded work. Nevertheless, relative rank was so unsatisfactory that the staff was amalgamated with the line, and some people think we then lost our engineers from the navy.

The epitome of aristocracy was found in the German army and navy; every officer had to present evidence of nobility before receiving his commission. It is not certain whether engineers in the navy conformed to this condition. However that may be, the deplorable condition of the German ships when surrendered has been charged in part to the fact that the engineers were socially an inferior caste.

The British navy about fifteen years ago undertook to deal with the friction between the deck officers and the engineer officers by drawing them from the same source and holding the chance open for young officers to pass from one corps to the other. Now after trial of this system they have decided that an engineer is different from a sailor and the chance is closed. The acknowledged difficulty is that the prize of high rank and command is not open to the engineer. A partial solution is to establish a number of positions for shore duty carrying the rank of admiral. They keep the priceless advantage of drawing all officers from the same source and, in part, of training them together.

This action of a navy that has just passed through the bitter experience of the great war should be considered by our naval authorities. The first line of defense of the honor and security of our nation rests and will rest with the navy. No snobbery that one duty is nobler than another should stand in the way of making our naval personnel the best.

LETTERS TO THE EDITOR

Attitude of Sea-Going Engineers

The public press has carried statements to the effect that the marine engineers employed on ocean steamers, through their representatives, have refused further negotiations with the representatives of the steamship owners of the Atlantic Coast.

To correct any misapprehension which might be in the minds of your readers regarding this matter, we beg to state that the marine engineers employed on sea-going vessels, through their organization, and in good faith, entered into an agreement with the various shipowners and the United States Shipping Board, said agreement covering the conditions of employment, wages paid, subsistence while in port and the hours of labor.

This compact was specifically stated to terminate on the first of May, 1921, the expectation being that on that date some superseding agreement would have been entered into and put in force.

The steamship owners, about the middle of January, requested the marine engineers to agree to a reduction in wages equivalent to 25 percent, an immediate elimination of overtime and several other important concessions.

The owners' representatives were informed that this proposition would be taken up and considered by the marine engineers' organization, a decision speedily reached and the owners notified of the decision.

We wish now to state to the owners and to the public that at all times the marine engineers are willing, through their representatives, to discuss any matter, or enter into negotiations having for their object the betterment of the American merchant marine.

New York. Bert L. Todd, Secretary.
Marine Engineers' Beneficial Association No. 80.

The Economical Cargo Ship

In the December number of this magazine there is a most important article by Mr. Alfred J. C. Robertson on the "Economical Cargo Ship," intended to enable a ship designer to so select the form and proportions as to secure the best results. Contrary to an idea formerly prevalent, the form and proportions of cargo ships have an important influence on the powers required to drive them, especially if relatively high speeds such as ten to twelve knots are desired; and changes of form that may at first seem unimportant are likely to have appreciable effect on power. This comes from the fact that cargo ships must have a large carrying capacity, which is best secured by having a considerable parallel body; the entrance and run must be faired to avoid undue resistance and to supply water to the propeller. The length of entrance and run are so reduced that wave interference is liable to occur.

The writer of this paper has unconsciously overcondensed it. Being familiar from daily use with the elements in which he deals—the forms and factors—he does not appreciate that the uninitiated, though a good naval architect, may have much trouble in reading and applying the article. Examples are supplied to illustrate the use of the diagrams of the article, from which a naval architect may learn how to use the data given, if he is ingenious and pertinacious. Had the author taken half again the space (which the magazine would doubtless be glad to use) the usefulness of the article would be doubled. The diagrams also are too small for convenient use and are in some cases so compressed that they overlap.

It is a secondary matter, but the use of Tideman's friction factors is to be deprecated. As has several times been pointed out, he made no experiments on friction but derived his tables from Froude's data. There is good reason to believe that Froude's values are too high, and the use of Tideman's values merely means that the naval architect is hedging to the amount of 5 percent. Now it is all right for the naval architect to hedge, but he should do so openly and should at least write down his margin in his own notes.

Washington, D. C. C. H. Peabody, Dr. Eng.

I appreciate the kindly criticism by Professor C. H. Peabody of my paper entitled "Economical Cargo Ships—Some Model Experiments" read last November before the Society of Naval Architects and Marine Engineers, and excellently reproduced in your December issue. I regret that it was presented in such a form as to make it difficult of application to the everyday needs of the naval architect.

It is true that the paper was very much condensed, but that was at the request of the society, whose finances last year were rather overburdened by the cost of printing the transactions. This also applied to the diagrams, which could have been much extended and enlarged. For example, the experiments were all conducted at four drafts, and the writer would gladly have included the effect of draft upon the C constant value, but as this was fully dealt with by Mr. Kent eighteen months ago, that part of the paper was sacrificed to the exigencies of space.

I agree wholly with your correspondent that the standard frictional coefficients of Froude should be used, but these would have been misleading to tank students in this country, who have only had tank tests of ships by the Tideman coefficients available to them. I have provided correction curves, Plate 4, which make the results contained in my paper available for comparison with results by Froude's coefficients.

With all the faults of presentation, however, I would take the liberty of suggesting that the information contained in the paper is well worth ingenious and pertinacious study by designers of full cargo ships.

New York. A. J. C. Robertson.

Comparison of Electric with Geared Turbine Drive in Merchant Vessels

Mr. Emmet's article on the above subject in your January issue does not seem to be quite fair to the geared turbine in the matter of comparative efficiency. The figures for electric drive are given as 92.5 percent for small powers and 95 percent for large powers, while gears are only credited with 93.5 percent for double reduction and 96 percent for single reduction.

Without wishing to dispute Mr. Emmet's figures for the efficiencies of electric transmissions, it must be said that they appear to be very high, and it would be interesting if he can give some additional information regarding the actual efficiencies of generators and motors, including excitation and the horsepower on which they are based. The mechanical efficiency of reduction gears depends to a great extent on the design and workmanship. The losses in the bearings are generally greater than in the gears, so that the net result depends largely on the number and dimensions of the bearings and on the conditions of lubrication. It is reasonable to assume that Mr. Emmet's figures for gear efficiencies have been obtained from tests of single and double reduction gears for marine propulsion as designed and built by the General Electric Company. The most widely distributed type made by that company for the propulsion of cargo vessels is known as the one-plane type, involving the use of three pinions and three gears with twelve or more bearings. This type of unit necessarily spreads over a large area of foundation which has to be supported on a structural frame work which is subject to considerable strain and distortion from the effects of wind and sea. In such circumstances the alinement of the different gear and pinion shafts may be difficult to maintain and a loss of efficiency must be expected. The figure of 93.5 percent is

probably based on a shop test, where the gears would be mounted on a rigid floor plate; hence it is quite reasonable to assume that the results under seagoing conditions would be no better, if as good.

A very large number of double reduction gears for cargo boats have been built by The Falk Company, of Milwaukee, Wis., and used with compound Parsons turbines. The fundamental idea which is expressed in the design of these gears is to avoid distortion by supporting the shafts in three planes in a very rigid frame standing on a relatively small and almost square base. Tests for rigidity have shown that it is practically impossible to throw the different bearings in one of these units out of line with each other, and there is no likelihood that mechanical efficiencies obtained in a shop test will differ materially from the net results which may be anticipated when the gears are operating in ships.

High Efficiency Shown in Tests

An actual test was made in June, 1920, on two of these units, rated at 3,100 shaft horsepower, reducing from 3,200 to 90 revolutions per minute. The test was very carefully conducted by running the two units in opposition to each other, while the equivalent of the power lost in friction was furnished by a motor, and the losses were measured electrically. On a long endurance run covering several hours the net overall mechanical efficiency of each gear unit averaged from 97.35 percent to 97.45 percent, showing a loss of about 2½ percent as compared with Mr. Emmet's 6½ percent.

A similar test was made in August, 1919, on two 6,000-horsepower single reduction gear units for compound turbines, 1,800 to 125 revolutions per minute. The net efficiency obtained on this test was 98.1 percent.

At a somewhat later date The Falk Company had occasion to build some more 6,000-horsepower single reduction units and a test of these was made in October, 1920. The later units were furnished with gears and pinions of larger diameter and greater face width than the corresponding gears in the earlier units. The pinion bearings in the later units were designed differently as the result of experience gained in the meantime. As a result the average efficiency from a 24-hour run, 98.32 percent, showed a marked improvement over the earlier test, notwithstanding the increase in gear dimensions. This figure of 98.3 percent compares very favorably with the 96 percent credited by Mr. Emmet to this type of gearing.

Causes of Failures

With regard to the portion of the article which deals with the possible causes of failures in marine reduction gears, the idea that this may have been due to distortions of the gear casings and consequent misalinement of gear teeth and bearings seems reasonable enough when considered in connection with the type of gear in which failures of this kind have been most conspicuous.

The tendency towards increased gear dimensions may be explained as being the outcome of a desire to play safe after unfortunate experiences with gears which were either too small for the work they were required to do or were designed with too little regard for the difference between conditions on board ship and on land. The correct proportions for rigid gears were sufficiently well known before there was any marked activity in this country in this particular line of endeavor. The Falk Company is using the same general dimensions now as then.

Under the circumstances it is interesting to note on page 31 of the advertising section in the same issue that contains Mr. Emmet's article that the original low speed gear on the S. S. *Pacific* is still in service after 230,000 miles of travel. The low speed gears for S. S. *Pacific* were furnished by The Falk Company.

The Falk Company, Milwaukee, Wis. Percy C. Day.

NEW BOOKS

Marine Engineers' Handbook

REVIEWED BY C. H. PEABODY, DR. ENG.

Marine Engineers' Handbook. By Lieutenant-Commander Frank Ward Sterling, U.S.N., Editor-in-Chief. Size, 4⅝ by 7⅛ inches. Pages, 1,486. Numerous figures, diagrams and tables. New York, 1920: McGraw-Hill Book Company.

This important work full of information was prepared by a staff of thirty specialists, each an expert in his own field. The editor-in-chief claims that it is a pioneer in its field, that the trail has not always been plain to read, and that this edition aims at a general survey of the new territory. This claim is not invalidated by the existence of an excellent handbook belonging to the period of the reciprocating engine, a type yet important, though its treatment in this book is compressed into 120 pages.

Of the staff three are professors, twelve are engineers, eight are administrative officers, three are experts and four are naval officers, though it might be proper to class all as engineers and experts. With all team work possible, the existence of so large a staff, each responsible for his own work, leads at once to congestion and over condensation. Some sections full of important information appear to be too extensive, such as those on metallurgy, special welding and steam turbines. Others are brief, as the powering of ships, heating and ventilation, electrical installations and refrigerating machinery. Others are frankly descriptive, like the sections on deck machinery and engine room auxiliaries.

The mathematical introduction deemed necessary for every engineering handbook is judiciously condensed. It is followed by a section on mechanics that cannot be so much commended, for example, the definition of momentum as the quantity of motion does not appear to have significance.

The section on metallurgy is excellent, compressing into small space information of the greatest importance to engineers on various alloys and iron and steel, together with a statement of heat treatment and of welding by the oxy-acetylene torch and by the use of thermit. Curiously, electric welding is not mentioned. One is led to wish that the writers might write a book for engineers and thus avoid the necessity for drastic condensation. The vast variety of modern "steels" is indicated by the list of metals used to make what are really iron alloys, namely, nickel, chromium, vanadium, molybdenum, tungsten, zinconium and titanium; all these besides carbon, silicon, sulphur and phosphorus which are likely to appear purposely, accidentally or as impurities.

The section on heat admirably assembles the data required by an engineer concerning heat and its effects on materials used in engineering, but why should the working engineer be troubled by general thermodynamic equations or a discussion on the real significance of entropy? The properties of steam are taken from a well-known and approved collection of tables, as good as any one of half a dozen authoritative tables now extant. All these collections are based on the same fundamental data, are correctly computed and give closely concordant results; any one may be taken as standard, but none is.

The section on fuels and combustion (coals, oils and gasoline) is brief and good, as is the description of apparatus for burning oils and the precautions for storing and using. The descriptions and explanations of instruments for determining viscosity, flash point, etc., are more detailed than needed, unless engineers are expected to make their own determinations. They doubtless could become experts, but should they?

The discussion of marine boilers by a well-known engineer of wide experience is well arranged and, on the whole, judicious. When space is so valuable as in a book of this sort

one begrudges even four pages on ancient history and the space given to detailed boiler tests. The space assigned to the Babcock and Wilcox boiler may be justified by the importance of this excellent type.

Nearly three hundred pages are given to the steam turbine; this is both too little and too much. It is too little for a turbine designer and too much for anybody else. A turbine designer needs a small library of books and a Molier's diagram as big as a table if he uses that method; even then it is a question whether he can properly compute reheat of the steam. There remains a question whether it is ever worth while. A large space is given to general illustration. The superficial description of the electric drive is as much as should be given to what is the electrical engineer's job. Hydraulic reduction gear does not deserve mention. It is notable that marine steam turbines tend to reduce to two types, the reaction or Parsons turbine, and the pressure compound turbine with an introductory velocity compound stage. Also by the use of some form of reduction gear, mechanical or electrical, the turbine tends to approach the stationary type and can be contracted for as a unit, so that the marine engineer is relieved from knowing too much of details.

The reciprocating engine has been obsolescent ever since Parsons put his turbine in the *Turbinia,* and is likely to remain obsolescent for a long time; it is unfortunate that the consideration of this old, reliable motor has been overcondensed. Selecting a small but important detail, the method of making a preliminary layout of cylinders and crankshaft on page 918 is excellent. On the other hand, the method of balancing, both by computations and graphically, is overcondensed to be useful. There are tables extant of acceleration for various crank and connecting rod ratios; if they are inaccessible for a handbook on account of copyrights they may be readily recomputed. Every proper handbook on reciprocating engines should have them as regularly as tables of properties of steam.

The information proper for a real discussion of the Diesel engine is in the hands of the makers; some day there will be a real handbook for internal combustion engines, but that day is not yet. The treatment of condensers and their auxiliaries, air pumps, condensate pumps, circulating pumps and vacuum augmenters is descriptive and good as far as it goes.

The very important matter of screw propellers by Admiral C. W. Dyson is presented in the form developed by himself during a period of years and used by himself, the staff of the Bureau of Steam Engineering and by some engineers in private yards. This method, which is credited with giving excellent results in practice, has been much under discussion and has been successively revised by its author to adapt it to the various conditions that have arisen. Anyone who wishes to master this peculiar method will find the discussion here presented an introduction to the author's "Screw Propellers for Hydraulic and Aerial Propulsion." In the development of his method the author has made his own terms and determined the methods of using them. When he uses customary terms he redefines them at will, sometimes giving quite a different significance, as, for example, his definition of thrust deduction, which is unlike Froude's term, having the same name. Noting a small but not unimportant item, the relative powers of two-, three- and four-bladed propellers are expressed by three constant factors given to four significant figures. Now experiments on model propellers, which cannot be gainsaid, show that the relations are not constant and they are not known to such a degree of precision. This treatment may be compared with that by Mr. Barnaby in a book reviewed in this magazine, a simple method used by him with success in designing the numberless propellers for Thornycroft and propellers for other builders.

Even in a book of fourteen hundred pages the pressure for space has made it necessary to compress the discussion of subjects like piping plans, deck machinery, evaporators, ventilators and ejectors, etc., etc. In much, if not in most, the editor's claim that the book is a pioneer is justified, and we may congratulate him and ourselves that we have so much as he and his staff have been able to give.

Marine Propellers

REVIEWED BY C. H. PEABODY, DR. ENG.

Marine Propellers. By Sidney W. Barnaby. Size, 6 by 8 inches. Pages, 230. Illustrations, 56. Tables, 13. New York, 1920: Spon & Chamberlain; London, E. & F. N. Spon.

This is the sixth edition of a well-known and highly valued book. The first edition was issued about thirty years ago; the author gave the first logical process for designing propellers based on experiments by the Froudes on model propellers. This work was presented in the form of a table by aid of which problems could be solved rapidly and certainly. Since that time the table has from time to time been improved and extended, this latest edition giving the greatest extension of pitch ratio and slip as yet proposed. Mr. Barnaby is the scientific expert for Thornycroft, and has designed not only all the numberless propellers for that company, but also propellers made or designed for other builders. This experience confirms the reliability of the method of designing propellers from the data obtained from experiments on models. This conclusion applies not only to Mr. Barnaby's method, but to the method of Admiral D. W. Taylor of the United States Navy.

Since the book is so well known, attention will be called only to new information or to characteristic features.

Next to the arrangement for convenient use of experimental data, Mr. Barnaby's most notable contribution to the profession was the identification of the phenomenon of cavitation and the prescription of methods for avoiding it. It still remains true that Mr. Barnaby's investigation of the phenomenon of cavitation on the *Daring* is unique. The only material addition to his report is the information that cavitation has not appeared in certain turbine steamers where his limits are exceeded. Mr. Barnaby concludes that the immunity is due to constant turning moment, and gives the caution that irregular turning moment experienced with some internal combustion engines is liable to lead to cavitation before his limit is reached. After long experience he confirms his opinion of the cause and remedy for cavitation. In particular he does not think that tip speed of the propeller has a determining influence. In this edition he gives tables showing speeds at which cavitation may be apprehended, computed both on 11¼ pounds thrust per square inch and on 13 pounds. The former is recommended for reciprocating steam engines and the latter for turbines.

A feature which was found in the previous edition deserves mention now, namely, the discussion of the influence of depth on speed based on tests in the model basin by Colonel Rota. This discussion shows what depth of water is most favorable for any ship of the destroyer type, and is useful both ways.

The British, having begun with paddle towboats and finding that they have certain conveniences, keep on with them, although in early times the advantages of the propeller were shown by the trials of the *Rattler* and the *Alecto.* This matter was tried again in 1913 when Thornycroft made competitive trials of paddle and screw towboats, demonstrating again that the screw could pull the hardest.

It is characteristic of aeronautical engineers that they not only use a different method for designing air propellers from that used by marine engineers, but that they tend to disqualify the information of that class of engineers and even seem to fear contamination of their science by contact with their methods. It is, therefore, the more interesting to know that Mr. Barnaby finds he can use his propeller table for designing screws for an airplane and obtain fair concordance with the aeronautical engineers' results.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY JAMES L. BATES

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Oil Fuel Atomizers

Q. (1113).—Will you please publish the method of calculating the design of an oil fuel sprayer, viz.: 900-pound oil fuel sprayer and how to obtain the number of sprayers required for a given boiler. L. T.

A. (1113).—The development of the atomizers at present in use has been largely the result of careful experiment. It is perhaps possible to derive laws based upon the information experimentally obtained, which would be of value in the design of oil burning apparatus, but it is understood that little has as yet been done in this direction.

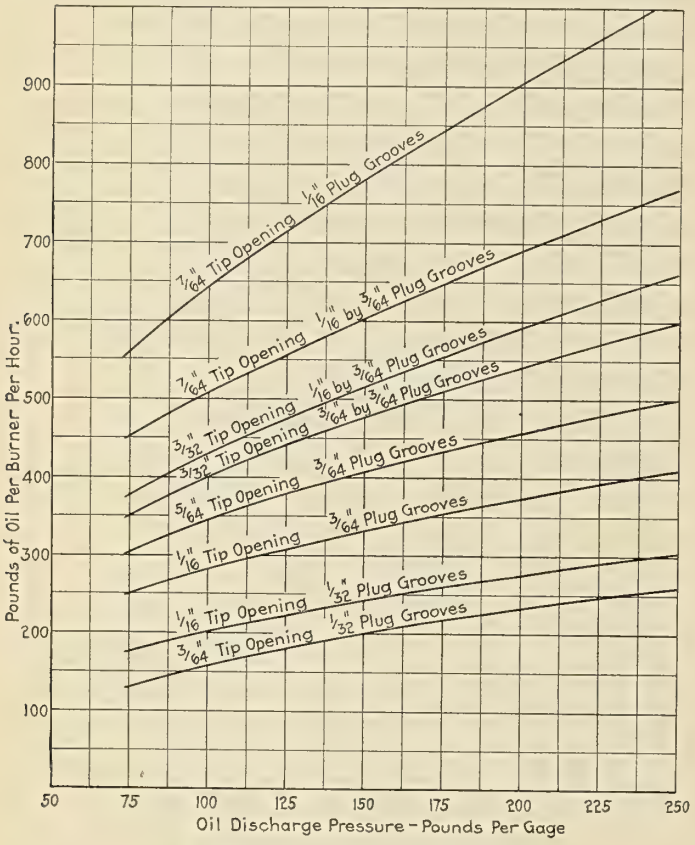


Fig. 1.—Pressure Capacity Curves

Fig. 1 shows pressure capacity curves which represent the results of the experimental work carried out by the Bureau of Engineering, Navy Department, with its Type 1 standard pressure atomizer. The three upper curves are based upon tests with Gulf Refining Company oil, specific gravity .8827 at 60 degrees F., viscosity 3.35 Engler or 115 Saybolt, temperature of oil 85 degrees F. The five lower curves are based upon tests with Texas oil, specific gravity .9115, temperature 90 degrees F., viscosity 7.02 Engler or 260 Saybolt.

Setting Blades of Sectional Propellers on Lake Steamers

Q. (1119).—One subject on which I am looking for information is propellers; more especially on the different methods of setting the propeller blades of a sectional wheel. We use many sectional wheels on lake vessels and also break them quite frequently. Oftentimes we have to put them on at night. The most common method employed at night, or at any other time, in setting the blades is to use a pitch board and sight from the pitch board to a straight edge held across the end hub. At night it is simply a case of guess. I have often thought that there must be other methods of doing this job that would be a whole lot more satisfactory. Oftentimes we have to put on blades under difficulties. Sometimes in the spring, when blades are broken working in ice, it is a case of pump the water ballast out so as to get the wheel above water, or rather the hub, and get down on the ice and replace the blades. In the running season they get broken in port, as we are usually drawing all the water in the harbor. D. N. H.

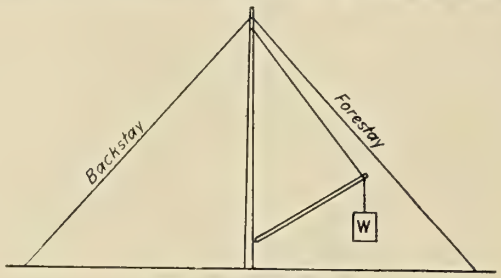
A. (1119).—For work under the difficulties which you describe it would probably be impractical to secure results of great accuracy. It may be that reference to pages 606, 607, 608 and 609, seventh edition of "Practical Marine Engineering," by Admiral Dyson, would throw such light on the principles underlying the whole subject as would assist you in making improvements in present methods.

Stresses in Rigging of Mast

Q. (1122).—Please solve the following problem: Suppose a mast, as shown in the sketch, to carry a certain weight on the boom; the stress on the mast and on the backstay can easily be determined. With the boom as shown, the mast would need no other support (theoretically). However, it is desired to rig a forestay. How is the stress in the forestay calculated so that the backstay will remain taut when the boom is unshipped?

What is the best book on strength of rigging and masts? A. L. D.

A. (1122).—From the wording of your question it is assumed that you desire to rig a forestay in such a manner that the backstay will remain taut under the tension of either the forestay or the boom topping lift acting singly. It is also assumed that a single backstay is fitted in the fore and aft line of the boom and forestay.



Sketch of Rigging

Now it is evident that a given tautness (tension) in the backstay can be maintained independently by either the forestay or the boom topping lift only when the horizontal components of each of these separate tensions are equal. Since the boom topping lift must necessarily make a more acute angle with the mast than does the forestay, in order that the boom end may have proper clearance, a greater tension will be required in the topping lift than in the forestay, if their horizontal components are to equal each other. This requirement presents no difficulty in itself for the reason that for the usual weight of boom and the load to be handled the tension in the topping lift will exceed that calculated for the forestay under the forces due to the weight of mast and all fittings, wind, angular acceleration due to pitching and weight of and tension in aerials, etc.

Since the forces previously enumerated may act on the

mast at the same time the weight is being hoisted by the boom, the backstay must therefore have sufficient strength to withstand the combined tensions of the boom topping lift and the forestay. Whether we assume that a given tension in the backstay is exactly balanced by either the tension in the topping lift or that in the forestay acting independently or the two acting simultaneously, it is obvious that equilibrium could be maintained only when the boom is in the fore and aft position shown in the sketch and sustains a constant static load, even were the tension in the forestay constant, which is not the case. It is readily seen that the topping lift tension will always be a variable quantity, for the instant the boom swings out of the fore and aft position the topping lift tension acts obliquely to the backstay, thereby reducing the tension in the backstay and inducing a tension in the shrouds on the opposite side from the boom. Hoisting or lowering the weight also changes the load on the boom on account of acceleration, while the removal of the load or the unshipping of the boom altogether practically or completely eliminates the topping lift tension.

In view of these considerations the impracticability of maintaining a constant tension in the backstay is apparent. Theoretically, at least, if an initial tension is set up in both the forestay and the backstay such that their horizontal components are equal and of such intensity as will equal or exceed the sum of the horizontal components of the maximum separate tensions in both the topping lift and the forestay, as calculated for the forces acting on each, then the tension in both the forestay and the backstay will remain unchanged whether the boom is in position and is being operated or is unshipped. This will result in fitting a much larger forestay than would otherwise be required. Such a design will usually be impracticable where heavy weights are to be handled, owing to the high initial tension required and the difficulty of securing it under the conditions of actual service.

In actual practice no attempt is made to maintain a constant tension in the backstay. Assuming that shrouds are fitted, their lower ends would necessarily have a drift aft in order to permit the boom to swing athwartship. In whatever position we assume the boom to be placed, the tension in the backstay will be affected by the action of the shrouds. This effect will vary with the position of the boom, and in practice is indeterminate because of the number of factors involved.

In cases like that shown it is customary to proportion the backstay so as to take the stress induced by the loaded boom, the mast being considered as hinged at the deck and the action of the shrouds ignored. This is done in order to simplify the calculations and eliminate, so far as may be, the allowance for bending in the design of the mast itself. (Of course, were no forestay or other similar supports fitted, the mast would have to be designed to be self-sustaining except when the boom is in use.) An allowance is made for initial tension or "set up" in standing rigging, the mast as before being considered as hinged at the deck, but no allowance for the effect of boom with its weight.

I am unable to recommend any one book which satisfactorily covers strength of rigging and masts. The recognized classification societies have rules and tabulations covering the size and type of the masts, spars and rigging for sailing and steam vessels. The "Shipbuilding Cyclopedia," published by Simmons-Boardman Publishing Company, New York, contains excellent type plans of masts, spars, rigging and detail fittings as blocks, smith work, etc. "Machine Design, Hoists, Derricks, Cranes," by H. D. Hess, gives valuable data on fiber stresses in timber; action of wire rope, stresses in same, etc., when handled over drums and sheaves; a discussion of graphics; blocks and block efficiencies, etc.; derricks and derrick fittings, with analyses of stresses and numerical examples.

Geared Turbines Versus Reciprocating Engines

Q. (1123).—Can you supply data showing a comparison of results from vessels fitted with geared turbines and with reciprocating engines? How do they compare as to fuel consumption, repairs, payroll, speed, power, etc.?

A. (1123).—The following data taken from the 1920 December issue of *The Shipbuilder* is an interesting comparison of "running costs" of motorships and steamships:

	1,000 Brake Horsepower Engines					2,400 Brake Horsepower Engines				
	Single screw, Diesel 1,000 B.H.P.	Single-screw, Double-reduction Geared, 1,000 S.H.P.		Single-screw, Reciprocating, 1,200 I.H.P.		Twin-screw, Diesel 2,400 B.H.P.	Single-screw, Double-reduction Geared, 2,400 S.H.P.		Single-screw, Reciprocating, 2,800 I.H.P.	
		Coal	Oil	Coal	Oil		Coal	Oil	Coal	Oil
Fuel, lb. per H.P. per hr.	.45	1.5	1.1	1.95	1.4	.45	1.5	1.1	1.75	1.25
Consumption, tons per day	4.82	16.1	11.8	25	18	11.6	38.6	28.3	52.5	37.5
Consumption, tons per 30 days	145	483	354	750	540	348	1,158	849	1,575	1,125
Price of fuel per ton	£11	£5	£10	£5	£10	£11	£5	£10	£5	£10
Cost of fuel per 30 days	£1,595	£2,415	£3,540	£3,750	£5,400	£3,828	£5,790	£8,490	£7,875	£11,250
Lubricating oil consumption, gallons per day	10	2	2	3	3	21	3	3	5	5
Lubricating oil, cost per gallon of	5/-	5/-	5/-	5/-	5/-	5/-	5/-	5/-	5/-	5/-
Lubricating oil, cost per 30 days	£75	£15	£15	£22 10s.	£22 10s.	£157 10s.	£22 10s.	£22 10s.	£37 10s.	£37 10s.
Personnel—										
Chief Engineer	1	1	1	1	1	1	1	1	1	1
Assistant engineers	3	2	2	2	2	6	3	3	3	3
Greasers	3	3	3	3	3	3	3	3	3	3
Firemen	—	3	3	3	3	—	9	6	9	6
Trimmers	—	3	—	3	—	—	4	—	4	—
Donkeyman	1	1	1	1	1	1	1	1	1	1
Electrician	1	—	—	—	—	1	—	—	—	—
Total engine-room staff	9	13	10	13	10	12	21	14	21	14
Total wages, 30 days	£191	£224 10s.	£195	£224 10s.	£195	£252 10s.	£380 10s.	£265	£380 10s.	£265
Total upkeep per 30 days, at 7s. per day	£94 10s.	£136 10s.	£105	£136 10s.	£105	£126	£220 10s.	£147	£220 10s.	£147
Total wages, fuel, oil and upkeep for 30 days	£1,955 10s.	£2,791	£3,855	£4,135 10s.	£5,722 10s.	£4,364	£6,413 10s.	£8,924 10s.	£8,513 10s.	£11,699 10s.
Ratio	1	1.44	1.97	2.12	2.93	1	1.47	2.04	1.95	2.68
Net saving per annum of 200 days sailing, Diesel over steam	—	£5,570	£12,650	£14,520	£25,250	—	£13,650	£30,390	£27,645	£48,850

No account is taken in this comparison of the savings effected for motorships in fuelling costs, less demurrage, additional cargo capacity, less accommodation for engine-room staff, no standby losses, less cleaning ship, higher average speed in a seaway, and reduced fuelling appliances required. On the other hand, the first cost of Diesel engines, Mr. Richardson states, is at present from 25 to 33 percent more than for steam plant. The economy of operation possible with the oil engine, however, is such that, granted reliable performance, the extra first cost is speedily balanced by the increased profits available.

PERSONAL MENTION

JOHN HUNTER, the well-known power plant engineer, has just accepted the position of chief engineer of the Heine Safety Boiler Company, St. Louis, Mo.

CLARENCE SAMUEL KING, for the past three years manager of the Philadelphia office and secretary-treasurer of the Delaware River section of the Atlantic Coast Shipbuilders' Association, has been elected secretary of the association succeeding Henry C. Hunter, of New York, who has been appointed counsel. In assuming his new duties, Mr. King announces the removal of the association's general offices from New York to 1701 Walnut street, Philadelphia. Mr. King will continue as secretary of the Atlantic Coast Shipbuilding Industrial Board which was established at the close of the world war by agreement with shipyard owners and international labor unions to adjust all questions pertaining to rates of labor, hours of work and conditions of employment in the signatory shipyards.

H. MCL. HARDING, consulting engineer, Harbor Commission, Milwaukee, Wis., gave an illustrated lecture on Docks, Quays and Piers at the thirty-seventh annual meeting of the Connecticut Society of Civil Engineers, held in New Haven, Conn., on February 15 and 16. Mr. Harding has been and is consulting engineer on many harbor developments. He is now preparing plans for improving New Haven harbor to make it a port of entry for vessels of deep draft.

G. L. BUCHANAN has been appointed by the Board of Managers of the American Marine Insurance Syndicates as the agent for Syndicate "A" in Cuba. Mr. Buchanan is a native American citizen; he is resident surveyor at Havana for the American Bureau of Shipping, which has consented to permit the Syndicates to utilize his services, both as surveyor and as agent, to represent the underwriters' interests in the care of wrecked and damaged vessels. This appointment will at once place at the disposal of the owners and underwriters the service of an expert, trained in the duties of the surveyor, who because of his detached position as the exclusive representative of the great American classification society and of the Underwriters Salvage Association, will be in an excellent position fully to protect the interests of both owner and underwriter of any American ship in trouble. Additional interest is attached to the appointment as it marks the first step in the development of the Syndicates' foreign policy of utilizing the services of our own nationals wherever adequate and available and, furthermore, is an evidence of the co-operative effort of classification society and salvage association to further the interests of the merchant marine.

JOSEPH W. POWELL, vice-president of the Bethlehem Shipbuilding Corporation, has recently been appointed president of the Council of American Shipbuilders. Mr. Powell is a graduate of the United States Naval Academy, where he not only excelled as a student but is also well remembered as an idol of the football team. After graduation he served four years as a naval officer and was detailed on the cruiser *New York* during the Spanish war. It was at the harbor of Santiago that Cadet Powell experienced the first great adventure of his life when he assisted Lieutenant Hobson in sinking the *Merrimac* for the purpose of bottling up the Spanish fleet. His own story of this daring feat is best told in his own words given at the time:

"About 2:30 P. M. I took the men, who were not going into the narrow mouth of the harbor, in the launch from the *Merrimac* and started for the *Texas*. I had to go back for Assistant-Engineer Crank, who had refused to leave the *Merrimac* to the last. I shook hands with Hobson the last of all. He said: 'Powell, watch the boat's crew when we pull out of the harbor. We will be cracks, rowing thirty strokes to the minute.'

"After leaving the *Texas* again I saw the *Merrimac* steaming slowly in. It was only fairly dark then and the shore was quite visible. We followed the *Merrimac* in, about three-quarters of a mile astern. When Hobson was about two hundred yards from the harbor the first Spanish gun was fired from the eastern bluff. We were then half a mile off shore in our launch, close under the Spanish batteries. The firing increased rapidly. We steamed in slowly, but lost sight of the *Merrimac* in the smoke. We ran in still closer to the shore so that the gunners on the heights lost sight of us. Then we heard the explosion of a torpedo on the *Merrimac,* but could not see her. Until daylight we waited outside the breakers half a mile to the westward of Morro. About 5:00 A. M. we crossed the mouth of the harbor again. In passing we saw one spar of the *Merrimac* sticking out of the water. We continued to hug the shore just outside of the breakers and then turned out to sea towards the *Texas* when the batteries saw us and opened fire upon us. It was then broad daylight. The first shot fired dropped thirty yards astern, but the other shots went wild. I drove the launch for all she was worth, finally making the *New York* in safety. The men behaved splendidly."

As a result of this service Congress promoted Mr. Powell to the rank of ensign and the Government sent him to Glasgow, where he studied shipbuilding and marine engineering for three years. After returning to America he was detailed by the Navy Department to the Cramps Shipyard at Philadelphia, where he supervised the construction of several of our warships. He then accepted the position of assistant to the president of the Cramps Company, where his work attracted the attention of Mr. C. M. Schwab, who gave him the position of president of the Fore River Shipbuilding Company.

During the war Mr. Powell's organization built a model destroyer building shipyard at Squantum, Mass., and two other plants. He secured the largest naval contract on record, totalling $130,000,000 and involving the construction of seventy-one ships. The story of this big contract is one of the most romantic incidents of the industry. Mr. Powell later became operating head of the entire Bethlehem Shipbuilding Corporation, Ltd., and today he is considered one of the foremost leaders in the shipbuilding industry, who commands the respect and confidence of all concerned in ship construction. Mr. Powell has also recently delivered several very constructive addresses before various societies and conventions in regard to our future shipping and shipbuilding policies. He has advocated the enforcement of the Merchant Marine Act of 1920, particularly the clause relating to discriminatory duties, an able and efficient Shipping Board, the repeal of the Panama Canal tolls on American vessels and a Cabinet position for the chairman of the Shipping Board. We wish him the same success in the future as he has had in the past, not only for himself but for the good of the American merchant marine.

WILLIAM M. KENNEDY, general works superintendent of the Chester (Pa.) yard of the Merchant Shipbuilding Corporation, has resigned to accept a position with the repair department of the United States Shipping Board. Mr. Kennedy has been engaged in shipbuilding in its various branches for twenty years. His first work was as an apprentice with the Maryland Steel Company, Sparrows Point, Md. He served from 1908 to 1915 in various navy yards as a draftsman, mechanic, supervisor of new construction, estimator and in charge of estimating and planning. He was associated with Commander R. D. Gatewood, director of construction and repair for the United States Shipping Board, when the latter was in charge of work at the Panama Canal. While at the Panama Canal, Mr. Kennedy played a prominent part in the installation of the planning and production system used in the canal dry docks and shops. After completion of this work he became associated with the Merchant Shipbuilding Corporation at their Harriman yard, holding the position of assistant production manager. He was later made assistant works manager and then assistant to the general manager. On April 1, 1920, he was transferred to the Chester yard of the company as works superintendent.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

EXTENSIVE CONSTRUCTION WORK AND PORT IMPROVEMENT FOR THE STATE OF LOUISIANA

Development of Waterfront at New Orleans Expected to Make it One of World's Greatest Ocean Terminals

Exhaustion of old world markets, with the consequent development of new ones, and revived use of inland waterways transportation have been the chief factors in the recent extensive development of New Orleans as a two-way port. When the Atlantic seaboard became so badly congested during the latter period of the war, the Government began to divert tonnage. Delays in eastern ports were hampering progress of the Allied armies. Then it was that New Orleans and other Gulf ports obtained a share of the tonnage and New Orleans ascended rapidly in the matter of exports.

The war also played a big part in the revival of inland waterway transports. Economical and efficient transportation became a national necessity. Idle rivers once more floated towboats and barges, and in this way the strategic location of New Orleans forced water and rail tonnage down the Mississippi Valley to the Crescent City for export. For years the commercial organizations of New Orleans had worked to interest the Government in greater use of the waterways.

This resulted in the War Department going into the New Orleans-St. Louis barge line on a large scale, and insured the ultimate success of the enterprise. Along with it, other waterway projects were given attention. The Warrior River was included in the barge line, giving the Alabama coal and ore mines a cheap outlet. Permission was granted to begin work on the canal connecting Chicago with the Mississippi; interest was revived in the Great Lakes-St. Lawrence project, and Ohio began to see some hope for the lock and dam system so long desired for the Ohio River.

That New Orleans is due to make greater strides seems a certainty. When all of these projects have been completed the rivers will bear a large volume of commerce, all of it floating down to New Orleans. The 20 percent differential on waterway transportation now maintained by the Interstate Commerce Commission will be a great incentive for shippers to use the improved waterways.

All of this merely explains the fortunate position of the port of New Orleans. It is a common sight to see an ocean liner docked at a New Orleans pier with one set of cranes loading cargo from a rail-served wharf while another set transfers freight from the hold of a river barge. Yet this is but one phase of the economy of transportation which the southern outlet has to offer. It is planned to have the port under the management of one efficient and competent person whose work is to be supervised by the Dock Board.

Just at this time, the State of Louisiana is going forward with three large enterprises which will increase materially the efficiency of the port. They are:

1—Building of an industrial canal and inner harbor at a cost of $20,000,000.

2—Construction of a coal tipple at a cost of $750,000.

3—Planning a $10,000,000 bridge across the Mississippi.

Started primarily as a war measure to enable New Orleans to build ships, the industrial canal and inner harbor are now intended to serve another purpose. They will give private enterprise a chance to develop river front facilities in strict accordance with its needs.

The industrial canal extends from the Mississippi River to Lake Pontchartrain, a distance of six miles. When completed both sides of it will be available for factory and warehouse. The canal will have a depth of 30 feet and a width of 300 feet. The great lock at the Mississippi River end will accommodate a ship 74 feet wide, 700 feet long and having a draft of 30 feet. There will be 35 feet of water on the sill practically all the time. An industrial strip of land 1,000 feet in width on either side of the canal will be served by the Public Belt Railroad, in this way once more effecting an economical co-ordination of rail-river-ocean transportation. The project is being financed by the Dock Board, the New Orleans Levee Board and the Public Belt Railroad, all public enterprises.

Railway Steamer Launched

The steamer Melines, 337 feet long, has been launched at the Armstrong yard of Sir W. G. Armstrong, Whitworth & Company, Ltd., for the Great Eastern Railway Company.

ADVANCE LECTURE PROGRAM FOR OCEAN ENGINEERS

The program of lectures thus far arranged for Ocean Marine Engineers' Beneficial Association No. 80, 15 Whitehall street, New York City, is announced by the Education Department of the association as follows:

March 15—C. R. Waller, DeLaval Steam Turbine Company; subject, "Geared Marine Turbines."

March 29—George F. Bateman, assistant professor of Mechanical Engineering, Cooper Union; subject, "Reciprocating Steam Engines."

April 12—W. E. Thau, Westinghouse Electric & Manufacturing Company; subject, "Electric Propulsion of Ships."

April 26—H. B. Taylor, Chief Turbine Engineer, United States Shipping Board; subject, "Marine Propulsion."

May 10—R. H. Rogers, General Electric Company; subject, "Marine Electric Auxiliaries."

May 11—Jos. J. Nelis, manager marine department Power Specialty Company; subject, "Watertube Boilers and Superheaters."

Other dates will be arranged later for lectures by Mr. P. C. Day, manager of the gear department of the Falk Company, on "Gearing," and Ernest H. Peabody, of the Peabody Engineering Corporation, on "Fuel Oil Burning."

WORLD'S TONNAGE FIGURES

It was stated in the British Parliament that the tonnage of merchant ships of 100 tons and upward owned by foreign maritime nations in July, 1914, as compared with the figures in 1920, was as follows:

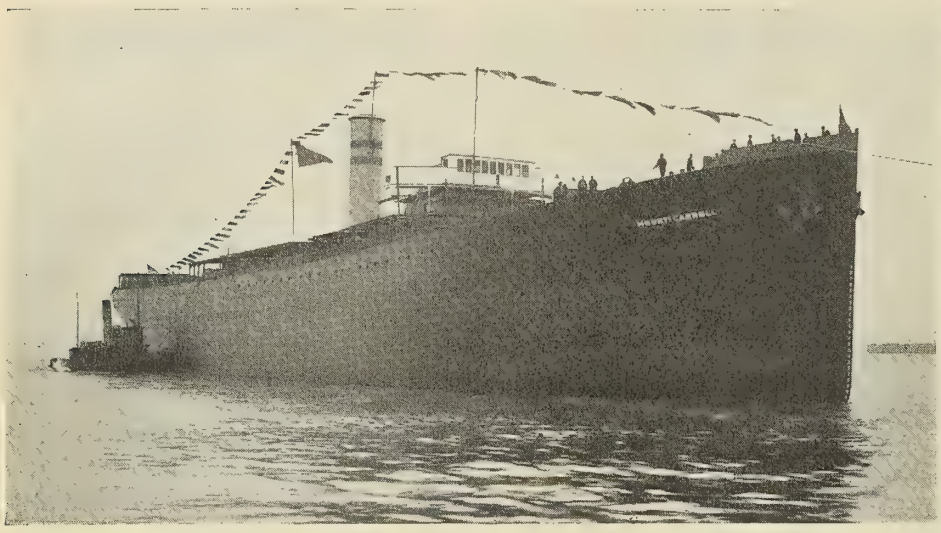
	July, 1914, Tons	July, 1920, Tons
United Kingdom (excluding British overseas possessions)	19,256,766	18,330,424
Total British Empire	21,045,049	20,582,652
Austria-Hungary	1,055,719	.....
Denmark	820,181	803,411
France	2,319,438	3,245,194
Germany	5,459,296	672,671
Italy	1,668,296	2,242,393
Greece	836,868	530,261
Japan (excluding sailing vessels)	1,708,386	2,995,878
Holland	1,496,455	1,793,396
Norway	2,564,722	2,219,388
Russia	1,053,616	534,547
Spain	896,823	997,630
Sweden	1,118,066	1,072,925

Mechanical Engineers' Convention

The spring meeting of the American Society of Mechanical Engineers will be held at the Congress Hotel, Chicago, Ill., May 23-26. Sessions are planned by the professional sections on aeronautics, fuel, machine shop, power, forest products and railways.

FIRST AMERICAN BUILT SHIPS FOR THIRD-CLASS PASSENGERS ARE LAUNCHED

"Mount Carroll" and "Mount Clinton" Give Distinctive Trans-Atlantic Service for United American Lines



Launching of the *Mount Carroll* of the United American Lines, the First American-Built Passenger Ship Intended for Exclusively Third-Class Passenger Traffic

At the Chester (Pa.) yard of the Merchant Shipbuilding Corporation on February 8, the steamship *Mount Clinton* was successfully launched. A sister ship, the *Mount Carroll,* was launched from this same yard on January 10, of this year.

Unusual interest attaches to the launching of these two steamers within a few weeks of each other, as they are the first vessels to be built in the United States exclusively for third class, transatlantic, passenger traffic. Both of these steamers have been built for the United American Lines, Inc., and are intended for that company's third class passenger service between New York and Hamburg, recently inaugurating the sailing of the *Mount Clay,* formerly the *De Kalb.*

This service marks a distinct departure in handling third class or immigrant traffic between Europe and America. The vessels are fitted out with a view to giving passengers of this class comforts and conveniences that they have not heretofore enjoyed. There are comfortable staterooms with two, four, six and eight berths, as well as dining saloons, waiting rooms and smoking rooms.

As the ships are devoted to handle one class of passenger travel, the passengers have the freedom of all the decks. The following is a description of the *Mount Carroll* and *Mount Clinton*:

The original design of these vessels covered the construction of a three-decked cargo vessel of the following dimensions:

Length overall	457 feet 0 inches
Length between perpendiculars	440 feet 0 inches
Beam, molded	57 feet 0 inches
Depth to shelter deck	39 feet 0 inches
Draft	28 feet 9 inches
Deadweight	10,500 tons

The vessel is constructed on the transverse system of framing and was divided originally by transverse bulkheads into five cargo holds and lower 'tween deck space. The space between upper and shelter decks was not divided into separate compartments. The machinery space is located amidships. Fuel oil is carried in inner bottom tanks, except the tank under the engine room, which is arranged for reserve feed water. A deep tank is built in aft of engine room and was originally fitted for fuel oil or water ballast. When it was decided to carry passengers this tank was fitted for fresh water.

As completed for emigrant service the vessel will have accommodations for 1,294 passengers and a crew of 141. The space between upper and shelter decks contains 20 two berth rooms, 94 four berth rooms, 12 six berth rooms, 2 eight berth rooms and one open compartment with 28 berths. Men's and women's general hospitals and infectious wards, dispensary and room for hospital attendant are located in this deck space. Main dining saloon, galley, bakery, butcher shop, pantries and a dietary kitchen are on the upper deck.

Quarters for 762 passengers are provided in the five compartments on the lower deck. All of this space is made available for carrying cargo by the removal of berths and stanchions. An auxiliary dining saloon and a small bar room were provided on shelter deck by extending the deck house.

Access to passengers' accommodations is provided by means of a stairway from auxiliary dining saloon and booby hatches placed in the corners of cargo hatches. Accommodations for officers are provided in deck houses amidships. Crew's quarters are situated aft on upper deck and stewards and other members of commissary force are berthed amidships on lower deck. Refrigerator, linen rooms and store rooms located in No. 3 hold and on flat built here especially for this purpose.

The propelling machinery consists of geared turbines of 4,200 shaft horsepower in conjunction with four oil fired Scotch boilers, with which a speed of 14 knots is expected. The vessel has oil bunker capacity for 9,500 miles, which will permit her to make a round trip without re-fueling and with ample reserve.

For cargo handling there are eight 8¼ inch by 10 inch steam winches for handling general cargo and two 10 inch by 12 inch compound geared winches at the forward hatch for handling heavy loads in conjunction with a 30-ton boom.

For lighting, and furnishing power to various small motors and fans, there are three 20 kilowatt electric generators in the dynamo room, each directly connected to a steam engine. One of these generators is a spare. There is an 18 inch searchlight mounted on top of pilot house, and ample lighting fixtures distributed throughout the passengers' and crew's accommodations and also on deck for handling cargo at night. In addition to the steam generators there is a 15 kilowatt emergency generator located on the bridge deck, connected to a gasoline engine, and arranged for lighting the accommodations and decks for operating the wireless in case of accident in the engine room.

For fire extinguishing, a system of steam smothering is provided for the cargo holds, and hose lines are provided for reaching all parts of the decks and quarters, connected to a large steam fire pump in the engine room. In addition to this there is provided an automatic fire detecting system for giving the alarm and location of a fire in any part of the vessel.

All parts of the accommodations are heated by steam and, in addition, a forced system of ventilation is provided. The sanitary arrangements, washrooms, etc., are in accordance with the latest practice and of ample size.

The refrigerating system consists of two 8-ton ammonia refrigerating machines located in a gas-proof compartment off the engine room, and arranged to operate on the brine circulation system, thus eliminating the danger of ammonia fumes getting about the ship. Either one of these machines has sufficient capacity to maintain the desired temperatures in the refrigerating rooms, which eliminates the risk of provisions spoiling, due to a breakdown. The refrigerator rooms are large enough to carry sufficient provisions for a round voyage without replenishing.

The *Mount Carroll* will be placed in service on the New York-Hamburg Service on April 5 and the *Mount Clinton* will be added a few weeks later.

The United American Lines operate this service in connection with the Hamburg-American Line, which will place three steamers on the route during the early summer, permitting regular weekly sailings to Hamburg.

MARINE EXPOSITION AT PHILADELPHIA DURING THE WEEK BEGINNING MARCH 14

The American Marine Exposition will be held in the First Regiment Armory, Philadelphia, during the week beginning March 14. It is planned to make this exposition of such proportions that it will be of national significance. Arrangements have been made for the attendance of national, state, and city officials. Figures of international reputation in the maritime world will be on the speakers' platform on the opening day. Among the public men who are to be present and take part in the opening exercises are Governor Sproule, Mayor Moore, Director Sproule, of Wharves, Docks and Ferries, and the heads of leading shipbuilding concerns in and around Philadelphia. Admiral Benson, chairman of the United States Shipping Board, has written to the management of the American Exposition expressing his desire to be present, in which event he will be one of the principal speakers.

Aside from its business aspect, the exposition will be so held that it will present a unique and interesting spectacle in a story of the American merchant marine told in graphic form. More than 15,000 feet of moving pictures depicting every phase of shipping, shipbuilding, salvaging and other maritime activities will be shown.

A program of specialties for each night has been arranged, March 14 being designated as Cramp's night; March 15, Sun night; March 16, Merchant's night; March 17, New York Ship Night; March 18, Pusey & Jones night; March 19, Philadelphia Navy Yard, Hog Island and Mathis night.

The list of exhibitors who have booths at this exposition includes the most prominent concerns that do business in shipbuilding, and among those who have already contracted for space are the following:

American Car & Foundry Co., American Brass Company, American Blower Company, American Bitumastic Enamel Co., American Society Marine Draftsmen, Atlantic Drier and Varnish Company, Atlas Crucible Steel Co., American Insulation Company, American Ship Supply Company, Automatic Transportation Co., Bethlehem Shipbuilding Corp., Bernstein Mfg. Company, B. Binswanger Company, Bridgeport Brass Co., Brunswick Refrigerating Company, Bituco Mfg. & Chemical Company, R. M. Baily Company, Chase Metal Works, Crane Company, Chicago Pneumatic Tool Company, Delco Light Products Company, J. H. Day Company, Dayton Pneumatic Tool Company, Davis-Bournonville Company, Eastern Machinery & Equipment Company, Ford & Zendig, Foster Engineering Company, Frecker Brothers, France Packing Company, Fisher Machine Co., M. Furstenau, Glenwood Tile Company, Hyde Windlass Company, Hadfield-Penfield Steel Company, K-G Welding & Cutting Company, Keasbey & Mattison Company, Kean, Sharon & Company, J. P. Christensen, Charles E. Lindh, Inc., Luckenbach Steamship Company, J. E. Lonegran Company, John Baizley Iron Works, Marine Equipment & Supply Co., McCambridge Company, Magnesia Assn. of America, Maritime Register, Marine Review, Morris Metallic Pkg. Company, Marine Decking & Supply Company, Merchants Shipbuilding Corp., Marine Engineering, John J. Mathews Company, Marshall Brothers, Merritt & Chapman Derrick & Wrecking Co., Marine News, Norwalk Lock Co., J. L. Mott Iron Works, New York Shipbuilding Corp., Eugene E. Nice, National Lead Company, National Bituminous Enamel & Paint Co., Pusey & Jones, Paschall Oxygen Company, Pneumercator Company, Phosphor Bronze Company, Row & Davis, Engineers, Inc., Paul S. Reeves Company, Seamen's Church Institute, Standard Underground Cable Co., Schuette & Koerting Co., Sun Shipbuilding Company, Scovill Mfg. Company, Sherwin Williams Company, Strawbridge & Clothier, George W. Smith & Company, Schlorer Mfg. Company, Thorne Pioneer Metallic Pkg. Co., Uhler & English, United Cork Company, Union Steam Pump Company, United States Navy, United States Rubber Company, Valentine & Company, J. B. Van Sciver Company, Weisbrod & Hess, Edgar T. Ward's Sons Company, White Fuel Oil Company (Todd Shipbuilding Corp.), York Mfg. Company, Vulcan Engine Works.

ALL-AMERICAN TERMINAL

Greatest of its Kind Planned for Hamburg, Germany

An American steamship terminal of the most modern type is to be erected at the port of Hamburg, Germany, according to an announcement made a few days ago by President P. A. S. Franklin, of the International Mercantile Marine Company. The terminal will be built with American capital, equipped with American machinery, and used exclusively by American steamers.

Adjacent to the Hamburg-American piers, the American terminal is expected to excel them in equipment and efficiency, and will rate as the finest in Germany. It will be built on the Ross Quay, one of the largest dock structures at Hamburg that remained incomplete at the beginning of the war, to which the American Line has taken a long lease. It will have a total length of nearly half a mile, with depth of water alongside to accommodate the largest passenger liners now operated in the American Lines service from New York. Sheds will be built of concrete and steel, 656 feet long, having a ground floor area of 2¼ acres. The latest type electric cranes will be installed, and trackage will be laid to connect the terminal with through rail lines by which American products will be moved to interior points in Germany, and to Czecho-Slovakia, Rumania, and other central European countries. The ships that will use this new terminal are now docking temporarily at piers secured on hire from the civic authorities of Hamburg.

TWO AMERICAN SHIPS TAKE INITIAL PLUNGE

The twin screw steel steamer *Henry D. Whiton* was launched on February 26 by the Newburgh Shipyards, Inc., at Newburgh, N. Y. The vessel is 356 feet long and of 7,000 deadweight tons. The ship is built to the order of the Union Sulphur Company, of New York, and special interest attached to the launching in view of the many innovations entering into the design of the vessel which will be used in special service for the economic handling and transporting of sulphur and similar cargoes in bulk.

The Blue Hen State

The steamship *Blue Hen State* was launched at the Camden yard of the New York Shipbuilding Corporation on February 23. The vessel is the last of a group of seven similar passenger and cargo liners built for the United States Shipping Board which are in operation in the north Atlantic and transpacific service.

The ship measures 522 feet over all with a beam of 62 feet; when completed will have a loaded gross tonnage of 21,900 and will be equipped with triple expansion engines developing 7,000 horsepower, and a speed of 14 knots.

The *Blue Hen State* and the steamship *Centennial State* launched last January, will be operated by the Ward Line between New York and Spanish ports by way of Cuba.

Election of Officers

Following the annual meeting of the executive committee of the National Association of Engine and Boat Manufacturers, Inc., 29 West 39th Street, New York City, the following officers were elected to serve for the ensuing year: President, Henry H. Sutphen; first vice-president, John J. Amory; second vice-president, Charles R. Criqui; third vice-president, George F. Lawley; treasurer, James Craig.

Pacific Mail Ship Launched

The steamship *Solanas,* built for the Pacific Steamship Company, San Francisco, Cal., by the New York Shipbuilding Corporation, Camden, N. J., was recently launched successfully.

LAUNCHED ABROAD

The steel cargo steamer *Vechtdyk,* built to the order of Messrs. Solleveld vander Meer and T. H. Van Hattum's Steamship Company, has been launched by Werf Gusto, Firma A. F. Smulders, Schiedam, Holland. The steamer is of 6,500 tons deadweight, is 359 feet long and is the third of four vessels of the same type under construction for this firm. Following this launching the keel was laid for one of two cargo vessels of 7,200 tons deadweight each on order by the steamship company, Triton, of Rotterdam.

The oil tank steamer *British Viscount* has been launched from the Neptune shipyards of Swan, Hunter & Wigham Richardson, Ltd., Newcastle-on-Tyne. The ship is being built to the order of the British Tanker Company of London, and is 455 feet long. She is designed to carry over 10,000 tons of oil.

At Southwick-on-Wear the same company has launched for the Atlantic Fruit Company of New York the steamship Saint Mary. This vessel is 270 feet in length, and will be equipped with triple expansion engines with boilers to be fired either with coal or oil fuel.

DEVELOPMENT PLANS

Present plans of the Transportation Committee of the Ingersoll Engineering & Construction Corporation, Liberty Building, Bridgeport, Conn., having to do with the reopening of Steeplechase Island as a summer resort this year, call for a ferry slip to be built at the Stratford Avenue dock, a floating dock and furnishing sufficient water with the present Seaview Avenue dock and ferry slip and floating dock to be added to the present pier at Steeplechase Island.

Dredging plans for the same enterprise call for the removal of approximately 20,000 cubic yards of material, the majority of which will be for the ferry slips and docks at the Steeplechase Island side and the balance directly in front of the Seaview Avenue dock, so as to permit the floating of the floating dock to be installed in connection for boats of 6 feet draft or less to anchor there.

Floating docks have already been purchased and it is expected that $50,000 or $60,000 will be expended in rebuilding the present docks and the building of the new ones outlined. Bids for the work will probably be opened within the next eight or ten days, according to official information obtained by MARINE ENGINEERING from General Manager Fred W. Pearce, of Josiah Pearce & Sons, Detroit, Mich., amusement builders and operators.

FORDONIA CONTRACT CALLS FOR DIESEL ELECTRIC DRIVE

The contract for the installation of motors, generators and similar electric equipment in the American freight steamer Fordonia, of the American-Mediterranean Steamship Company, was awarded to the General Electric Company on March 3, it has been officially announced. The ship is also to have two Ansaldo internal combustion engines, which will be installed by the Todd Shipyards Corporation.

BIDS FOR MOMUS WILL BE OPENED APRIL 7

Bids for the reconditioning of the Southern Pacific Company's freight and passenger ship Momus, which is to have new boilers and oil-burning equipment to replace the present coal-burning system, will probably be opened on April 7, according to announcement to-day. Superintending Engineer A. S. Hebble, of the Southern Pacific Company, arranged the plans and specifications, and Babcock & Wilcox boilers fitted with B. & W. oil burners will be installed.

FRENCH SHIPBUILDING

Statistics recently published show that the French Mercantile Marine has already been restored to its pre-war basis. The Rapport Generale sur l'Industrie Francaise states the total merchant tonnage on December 31, 1919, was 2,400,896 tons, or approximately the same as prior to the war.

BUSINESS NOTES

The Consolidated Instrument Company of America, 461 Eighth Avenue, New York City, announces its formation "to render manufacturers, engineers, and designers a complete engineering sales service in connection with all types of speed indicating and recording instruments and devices." The company controls exclusively the entire American distribution of the Jones tachometers and various other recording devices.

It is announced that the New York Shipbuilding Corporation, Camden, N. J., has placed an order with the Matthews Engineering Company, of Sandusky, Ohio, for 18 Matthews full automatic self-starting units which are for use on the top deck of ships to take care of wireless, deck passage lighting and the lighting of davits for emergencies such as recently happened to the Spanish steamer *Santa Isabel,* which was wrecked while the passengers were asleep.

Announcement is made by the Atlas Valve Company, Newark, N. J., that they have added to their line of valves, pumps, governors, pressure regulators, etc., the "Ideal" automatic pump governors, having acquired sole patents and rights to manufacture by purchasing from the Ideal Automatic Manufacturing Company. This pump governor has been approved by the United States Navy and by the National Board of Supervising Inspectors of Steam Vessels for controlling certain exacting operations.

A. C. Rimmer, consulting engineer and naval architect, 149 Broadway, New York, has been made district sales manager for the Northwest Engineering Works, of Chicago, Ill., to concentrate particularly on the Northwest crawler crane, which, like the war tanks, travels under its own power on two manganese steel crawler type wheels. Its lifting capacities range from 5,200 to 20,000 pounds.

It is announced that Barimar, Ltd., 10 Polen Street, London, in addition to the overseas branches they are now maintaining, have established new service depots in Birmingham, Manchester, Newcastle and Cardiff at each of which their special metallurgical process will be in operation.

The Chicago Pneumatic Tool Company announces the resignation of Mr. H. L. Dean, formerly manager of the compressor and engine sales division. Mr. J. F. Huvane has been appointed as eastern manager of this division with headquarters at 6 East 44th Street, New York City, and Mr. G. C. Vanden Boom as western manager of the division with headquarters at 300 North Michigan Boulevard, Chicago.

The C. H. Wheeler Manufacturing Company, of Philadelphia, Pa., manufacturers of condensers, pumps, feed water heaters and water cooling apparatus, has opened a branch sales office in the Leader News Building, Cleveland, Ohio. Mr. W. K. Eicher is in charge.

The Hooven, Owens, Rentschler Company, of Hamilton, Ohio, announce the appointment of the John Fensen Company, Richmond, Va., as their representative in the Virginia territory; the Sunderland Machinery and Supply Company, Omaha, Nebr., as the representative in the Omaha district, and Mr. Walter T. Paine, as representative in the Boston district.

Announcement is made of the appointment of George L. Cook as manager of block distribution for the Marine Decking & Supply Company, manufacturers, contractors and engineers, of Philadelphia, Pa.

The southern office of the Consolidated Shipbuilding Corporation, Morris Heights, N. Y., designers and builders of motor yachts and their machinery, will be reopened this season at 1100 Boulevard, Miami, Fla., under the direction of Mr. Clement Gould Amory.

Mr. S. J. Lenher, president of the Lenher Engineering Company, New York, who assumed the general management of the S. Flory Manufacturing Company, Bangor, Pa., upon the death of Mr. Samuel Flory, has been elected president of the S. Flory Manufacturing Company, and will direct its affairs from the home office at Bangor.

The Locomotive Superheater Company has acquired the patents and business of the Locomotive Feed Water Heater Company. The Locomotive Superheater Company will conduct the further application of the apparatus for preheating feed water, through its regular engineering, inspection and service organizations, to which has been added the operating organization of the Locomotive Feed Water Heater Company. This consolidation of resources and effort promises more intensified development and better service to the railroads.

George J. Blanton, who for the past four years has been connected with the Engineering Sales Department of Chain Belt Company, Milwaukee, has been made New York District Manager, with offices at 50 Church Street. Before joining the "Rex family" in 1917, Mr. Blanton was associated with the General Electric Company for eight years. He is a graduate of the University of Michigan Department of Mechanical and Electrical Engineering, class of 1909. He will leave immediately to take charge of the company.

The office managers of the several district offices of The Cutler-Hammer Manufacturing Company were in attendance at a general sales meeting held in Milwaukee, during the week of February 14 to 19, under the direction of W. C. Stevens, sales manager of the firm.

Malcolm R. Maclean has resigned as secretary and sales manager of the Duquesne Steel Foundry Company to become sales manager, castings division, Penn Seaboard Steel Corporation, Philadelphia.

Mr. E. L. Mills, formerly in charge of the sales of the Klaxon marine signals and telephone equipment in the New York district, has been appointed district agent for Klaxon Industrial Products in eastern Pennsylvania and in adjacent New Jersey, Delaware and Maryland. His temporary address is 248 North Broad Street, Philadelphia, Pa. Mr. Paul M. Farmer succeeds Mr. Mills in the New York district.

Mr. Harry L. Oviatt has been appointed traveling representative of the Armstrong Manufacturing Company, of Bridgeport, Conn., manufacturers of pipe threading tools and taps. Mr. Oviatt has been with the Bullard Machine Tool Company for the past thirteen years; for the past three years connected with the advertising department.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIPS AND SHIPBUILDING

Ship Repair, Baltimore, Md.—The H. E. Crook Company is reported to have been awarded the contract for repairing the Shipping Board steamer Otho.

Foreign Orders.—According to a report from Montreal, shipping interests in Jugo-Slavia are desirous of having some ships of from 2,000 to 15,000 tons built in Canada.

Overhauling Vessel, Jacksonville, Fla.—The steamship Jacksonville has been put into dry dock at the Merrill-Stevens yard for minor repairs and will also be scraped and painted.

Steamboat, Sarasota, Fla.—According to a recent report, the Chamber of Commerce is in the market for a steamboat about 100 feet in length, 4½-foot draft, suitable for carrying both freight and passengers.

Sidewheel Steamer, Memphis, Tenn.—According to an announcement made by Captain Peters Lee, the Lee Line will build a 160-foot sside-wheel steamer capable of handling 700 tons of freight, for which it is expected the contract will be let next spring. The vessel will cost about $100,000.

Overhauling Large Liner, Seattle, Wash.—At an expense of nearly $125,000 the Pacific Steamship Company has authorized the complete overhauling and renovating of the coastwise passenger liner President, which work is now nearing completion at the plant of the Todd Dry Docks Corporation, Harbor Island.

Tugs and Barges, Algiers, La.—It is reported that the Johnson Iron Works, Drydock & Shipbuilding Company, Inc., has received a contract to construct towboats and barges for the Gulf Refining Company. The equipment to be furnished includes two steel barges, one steel hull and one towboat.

Repairing Steamer, Victoria, B. C.—The largest and most expensive repair job to be carried out in British Columbia is that of the G. T. P. steamer Prince Rupert, which was floated after two months' salvage operations and towed to the Yarrows, Ltd., yard. The job will require 115 days for completion and will cost $258,000.

Freight Steamers, Vancouver, B. C.—It is reported that the Coughlan Shipyards contemplate building two 8,800 deadweight ton standard freight steamers to add to their own fleet, and it is expected that they will be ready by next summer. The Kingsley Company, Vancouver, B. C., plans another vessel for its San Francisco run.

Submarine Chaser for Fireboat, Boston, Mass.—It was learned that the Navy Department has turned over to Boston a submarine chaser which will be reconditioned and converted into a fire-fighting craft. Fire apparatus will be installed and the necessary changes in the boat made, and it is announced that this work will be done in Boston.

Repairing Steamer, Mobile, Ala.—The steamship Dade County, of 5,076 tons deadweight, has been placed in dry dock by the Alabama Dry Dock & Shipbuilding Company, where she will undergo extensive repairs made necessary by damage from fire in New Orleans last month. One hundred shell plates will be removed, as well as a number of deck plates. Work is to be completed in sixty days.

New Steamship Considered, San Francisco, Cal.—Information obtained recently was to the effect that the Oceanic Steamship Company of San Francisco, Cal., has been contemplating the building of a new ship. In an official announcement to MARINE ENGINEERING the Oceanic Company stated, however, that the matter of building has not yet been definitely decided, owing to present conditions.

Repairing Vessel, Hoboken, N. J.—A contract for repairing the Southern Pacific steamship El Occidente, which was damaged as a result of a fire on December 23 at Galveston, Texas, was awarded to the Tietjen & Lang Dry Dock Company, of the Todd Shipyards Corporation. Removal of 130 plates will be necessary. The successful bidder was awarded the contract on a price of $150,000 and forty days.

Electric Drive for Vessel, Brooklyn, N. Y.—The contract for installation of electric drive in the United States Shipping Board ship Archer, 12,000 tons deadweight, to replace the war emergency geared turbine equipment, was awarded to the Tebo Yacht Basin Company, Brooklyn, on a bid of $83,700. The work is to be completed by May 2. The Archer is a sister ship of the Eclipse and the Invincible.

Reboilering the Plymouth, Newport, R. I.—The steamer Plymouth, of the New England Steamship Company, has been taken from her Eastern run and is being reboilered at the company's repair plant, Newport. Six Babcock & Wilcox boilers, having a heating surface of approximately 16,500 square feet, will be installed. The Plymouth will probably be back in service in time for the beginning of the spring business.

Tankers, San Francisco, Cal.—That contracts for the building of four oil tankers for the Union Oil Company will be let following the sale of three smaller tankers, was the announcement made recently, and credited to A. O. Pegg, superintending engineer for the company. Three of the new tankers will be of 12,500 tons, with a capacity of 85,000 barrels of oil each, and one of 7,500 tons, with a capacity of 50,000 barrels.

Steamer to be Overhauled, Copenhagen, Den.—The steamer Oscar II, of the Scandinavia-American Line, has been sent to Messrs. Burmeister & Wain's yard, at Copenhagen, for overhauling and she will at the same time undergo extensive alterations. In future it has been decided that she shall have only two classes for passenger, namely, cabin and third-class, instead of as at present, first and second classes, which will be converted into one.

To Equip Steamer with Electric Drive, New York.—The American freight steamer Fordonia is to be equipped with Diesel electric drive, according to announcement of McDonnell & Truda, New York agents for the American Mediterranean Steamship Company. The engines are to be two Ansaldo San Giorgio Diesels, 4-cylinder, 2-cycle and 500 brake-horsepower, and are now on their way here from Italy. The installation will be by the Todd Shipyards Corporation.

To Overhaul Vessels, San Francisco, Cal.—The entire fleet of eleven German barks recently bought by the Robert Dollar Company will be thoroughly overhauled and repaired, after which they will be placed under American registry and put in general shipping service. One of the sailers, the Hans, has already arrived in San Francisco, and three more are expected soon. The entire fleet is expected to be brought to San Francisco toward the end of April or the middle of May.

Auxiliary Schooner.—W. Starling Burgess, Portland, Maine, is designing an auxiliary schooner, to be one of the largest ever built, for a member of the New York Yacht Club, whose name for the present is withheld. The vessel is to be built of steel and will be 210 feet overall in length, and 160 feet waterline. The three-pole masts will spread 16,000 square feet of sails. A steam engine of 750 horsepower will furnish auxiliary power for the vessel, which is intended primarily for ocean cruising.

Bids for Ferryboats, San Francisco, Cal.—It is announced by President Forbes H. Brown, of the Six-Minute Ferry Company, that the company will be ready to accept bids on the construction of three boats within a week or so. Hull construction of the new boats will be similar to that of the Edward T. Jeffrey. The superstructure of the main deck will be high enough to clear the largest moving vans of any of the bay cities, and each boat will have ample room for eighty machines, arranged in three rows on each side of the boat.

Engines for Barges, Oakland, Cal.—It is announced that the Skandia Pacific Oil Engine Company has been awarded contracts to install Diesel engines in new canal boats to be used on the Erie Canal. Installing of these engines heralds the passing of the mule and the towpath on the Erie Canal as a means of propelling boats through New York State. The plans of the state include the construction of canal boats, 250 feet long, 36 feet beam and 14 feet deep. The barges will be built in Duluth and the engines shipped from California. The contracts are for $150,000.

Activities in Halifax.—The Halifax Shipyards, Ltd., Halifax, N. S., have two ships of 10,500 tons each in the course of construction and it is expected they will be delivered next June. In addition, the company has a large amount of repair work on hand. It is also reported that the company has in prospect orders for the construction of five large oil tankers. This work would be sufficient to keep the Halifax yards, as well as those of the Davie Shipbuilding & Repair Company, at Lauzon, Que., and the Tidewater Shipbuilders, Ltd., at Three Rivers, Que., busy during 1921.

Turbines Instead of Diesels to be Installed.—The Bethlehem Shipbuilding Corporation has abandoned the plan of equipping its four new 20,000-ton ore carriers with Diesel engines. It has been learned that the corporation has decided to install steam turbines instead of the internal combustion engines. No announcement was made by the company of this change in decision, but it is reported that the Bethlehem Union plant has been ordered to start on the construction of the turbines for these vessels, two of which will be built near San Francisco, while two will be produced at the Sparrows Point plant of the Bethlehem Corporation.

Yards Busy on Private Work, San Francisco, Cal.—A review of the San Francisco Bay shipyard situation shows the industry here has settled down to a business-like basis. The Bethlehem Shipbuilding plant has started work on two $5,000,000 ore carriers, which will require a year for completion. The Moore Shipbuilding Corporation has started on a 16,340-ton tanker for the Southern Pacific Company to be used on the Atlantic Coast, while four 10,000-ton vessels are now on the ways. The new plant of the Union Construction Company has started work on a 10,200-ton tanker for the Anglo-Saxon Petroleum Company. The yards are also busy on a vast amount of ship repair work.

To be Converted into Oil Burner.—The present coal-burning equipment of the Southern Pacific Company's freight and passenger ship Momus will be replaced by new boilers and oil-burning equipment early in the spring. It is expected that the Momus will run until April. Bids for the reconditioning of the ship will be opened in the near future. Arrangement of the plans and specifications have been made by Superintending Engineer A. S. Hebble of the Southern Pacific Company. Babcock & Wilcox boilers fitted with B. & W. oil burners will be installed in the ship and the boilers will have a heating surface of approximately 22,680 square feet and 2,250 square feet of superheating surface.

Tanker, Oakland, Cal.—The keel for a 16,340 deadweight ton tanker, to be built at an approximate cost of $3,250,000, was laid last month at the yard of the Moore Shipbuilding Company for the Southern Pacific Company, New York. She will be 520 feet overall length, 71 feet beam, 39 feet deep, to load to 28 feet, and will be fitted with Scotch boilers having 220 pounds working pressure, to operate quadruple expansion engines. The pumping outfit will consist of two compound horizontal duplex oil pumps with a capacity of discharging 6,000 barrels an hour. The vessel was designed by A. S. Hebble, superintending engineer of the Southern Pacific Company, and will be built on the Isherwood system of longitudinal construction.

Reconditioning Steamers, New York.—Plans and specifications for extensive reconditioning of the steamships America and George Washington, of the United States Mail Steamship Company, Inc., 45 Broadway, New York, have been completed preparatory to the asking for bids on these two ships. It is planned to put these steamers in first-class condition in order that they may compete with the very best passenger liners. While no definite figures could be obtained, it is understood that the work of putting these ships into the desired condition will occupy a considerable length of time and will cost in excess of $2,000,000. The George Washington is a vessel of 15,379 tons and the America of 13,637 tons.

Repair Contract, Brooklyn, N. Y.—The steamship St. Louis, at one time crack transatlantic liner, has been sold at auction for $250,000 to the Anderson Company, of Montreal, Can., and has been taken to Erie Basin, where the Robins Dry Dock Company will put the ship in condition so that she may be taken to England, where, it is understood, she will be placed in British service under the British flag. The steamer Narragansett, which for several years was engaged in service through Long Island Sound between New England ports and New York, is also at the Robins plant undergoing reconditioning preparatory to being taken abroad by European interests. During the war the Narragansett served in the English Channel.

Fletcher Yards Busy, Hoboken, N. J.—Reconditioning of the steamship Kilpatrick, recently used as an army transport, has been started by the W. & A. Fletcher Company, to whom the contract was given by Stephen Stephanidis, 24 State street, New York, who will operate the ship as a passenger and freight steamer, running between New York, Constantinople and Piraeus. The contract will be completed in thirty days. Work has also been started on extensive reconditioning of the 3,275-ton ship Suriname, of the United Fruit Company. This job includes, among other things, insulation, building up of the stern and a new deck house. It is expected she will be finished about the middle of March. The Fletcher Company will also recondition the United Fruit ship Coppename, starting the work in March and completing it in May.

New Vessel Construction, New York.—Twelve vessels are at present in various stages of construction under the supervision of Whittelsey & Whittelsey, naval architects, of 17 Battery Place, New York City. Ten of these ships, three tankers and seven embarkation steamers, will be of concrete, for the war department, and are being built by the Newport Shipbuilding Company, Wilmington, N. C. The tankers will be of 3,500 tons, 300 feet long by 44 feet beam, by 24.6 feet depth, to be equipped with 1,500 horsepower engines. The embarkation steamers will be double deck, 150 feet long, each to be equipped with two 450-horsepower Winton Diesel engines. One steel steamer, 135 feet long, is being constructed for the International Petroleum Company of New York, to be used for mooring and maintenance service. A second steamer for the Atlantic Gulf Oil Company is being built by Kyle & Purdy, of City Island, New York.

SHIPYARDS AND DRYDOCKS

New Shipyard, Huntington, W. Va.—It is reported that J. P. Hetherington will construct a shipyard to build ferryboats.

Dry Dock Crane, Ogdensburg, N. Y.—The St. Lawrence Marine Railway Company plans to install a 20-ton electric dry dock crane.

Shipyard Addition, Morris Heights, New York.—The Consolidated Shipbuilding Corporation will build a one-story power house at its works.

Drydock, Akron, Ohio.—The State Board of Public Works, State House, Columbus, Ohio, plans to build a concrete drydock near Akron, involving the expenditure of about $20,000. Kinnear & Whitlock, State House, Columbia, are the engineers.

New Building, Detroit, Mich.—The Belle Island Boat & Engine Company, 2096 East Jefferson Avenue, is planning the erection of a new one-story factory on East Jefferson Avenue. The plant will be reinforced concrete and brick and 90 by 150 feet.

Repair Plant Sold, San Francisco, Cal.—Advices from San Francisco announce the acquisition of the oldest shipsmithing establishment on the Pacific Coast, the firm of Muir & Symon, by John M. Mooney and James F. Young, both formerly of the Skinner & Eddy Corporation.

Marine Railway, Havana, Cuba.—The Munson Steamship Line will build a marine railway for its own use at Mariel Bay, which is located a few miles from the port of Havana. The marine railway will be constructed to enable the company to keep its ships operating efficiently.

Shipyard Additions, Elizabeth, N. J.—The Bethlehem Shipbuilding Corporation, Front Street, has plans under way for a number of additions to its Moore shipbuilding plant, to cost more than $800,000, and it is expected that construction will begin in the early summer.

New Shipyards, Buenos Aires, Arg.—An Argentine company, with a capital of 50,000,000 pesos, is being formed at Buenos Aires, Argentine, S. A., with the object of establishing shipbuilding yards at the port of Carmen de Patagonia, and constructing vessels for the European trade. It is reported that a local German firm will provide some of the capital.

Floating Dry Dock Wanted, New York.—On behalf of a client, J. R. Wemlinger & Company, Inc., engineers, 140 Broadway, New York, is in the market for a floating dry dock to accommodate vessels up to about 6,000 tons. This dry dock is to be complete with all necessary equipment, and delivery will be taken at any Atlantic or Gulf port, preferably the latter.

New Shipyard to Be Built, Tottenville, S. I.—The Union Shipyards Corporation is arranging for the construction of a plant on property fronting Staten Island Sound, which will be used for the repair and construction of tugs, barges, lighters and other vessels. The company has a tract of about eight acres and is reported to be in the market for a locomotive crane.

Building Dry Dock Plant, North Bergen, N. J.—The Lord Dry Dock Corporation, 105 West 40th Street, New York, has construction under way on its new dry docks at Woodcliffe. A number of buildings will also be erected, including machine shops, metal-working plant, woodworking shops and other structures. The project will involve the expenditure of about $5,000,000.

Repair Base, San Diego, Cal.—After many months of waiting, the Navy Department has finally taken over the former concrete shipyard of the Pacific Marine & Construction Company, and has started converting the yard into a fleet repair base. The base, designed to meet the requirements of the destroyer, mine sweepers, and other craft permanently based here, will be equipped with a marine railway, machine and woodworking shops and several concrete piers.

Shipyard Addition, Brooklyn, N. Y.—Stephen Ransom, Inc., 518 Hamilton Avenue, has awarded a contract to the Wharton Green Company, 37 West Thirty-ninth Street, New York, for the construction of a one-story machine shop, 120 by 160 feet, to cost about $200,000. The Wharton-Green Company was also awarded another contract by the same firm for the construction of a four-story building at its marine repair works. The latter building will be 80 by 200 feet.

Shipyard Improvements, Chester, Pa.—Numerous improvements are contemplated by the management of the Chester yard of the Merchant Shipbuilding Corporation during 1921, including additional machine tools in six of the biggest shops; enlargement of shipways to take care of building larger hulls, and safety devices throughout the yard in general. Additional machinery is contemplated for the pipe, pattern, joiner, blacksmith, machine and fabrication shops, including jib cranes and electric hoists, for the handling of fabricated material.

PORT IMPROVEMENTS

Docks, Houston, Tex.—The city is having plans prepared by the city engineer for remodeling the municipal cotton docks.

Channel, Mobile, Ala.—The Chamber of Commerce is interested in improving the channel at Bayou la Batre. Major Earl North is United States district engineer.

Docks, Etc., Amherstburg, Ont.—C. Wigel & Sons, River Front, plan to build a warehouse and new docks in connection with their flour mills, involving expenditure of about $40,000.

Dredging, Miami, Fla.—The city has voted bonds to the amount of $100,000 to deepen the 300-foot channel slip from 15 to 22 feet, and the 1,000-foot channel slip from 10 to 17 feet. C. W. Murray, Miami, is engineer.

Docks, Melbourne, Australia.—Work will soon commence on the first part of the development program planned for the port of Melbourne, Australia. Four new docks to cost £6,000,000 will be constructed, and six others will be constructed later as required.

Docks, Slips, Etc., Norfolk, Va.—A new steamship line, to be known as the Hampton Roads Transportation Company, has been chartered under the laws of Virginia, with a capital of $500,000, to operate a ferry line for both passenger and automobiles between Willoughby Spit and Phoebus, Va., early in the spring. Plans for the building of the docks and slips are already out, and bids for their construction will soon be opened. Mr. John N. Haden, Seaboard building, Norfolk, Va., is president.

GOVERNMENT WORK

Pier, Charleston, S. C.—Specification 4363, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to build a reinforced concrete pier.

Heating System, San Diego, Cal.—Specification 4366, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install a heating system.

Refrigerating Equipment, Newport, R. I.—Specification 4363, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install a refrigerating system at the Naval Hospital.

Electric Distributing System.—Specification 4369, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install an electric distributing system for Slips 2 and 3 at Philadelphia, Pa.

Foundation for Crane Runway, New York.—Specification 4362, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to build foundations for steel storage crane runway at New York.

Radio Quarters, Mare Island, Cal.—Specification 4361, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to build radio quarters at Loma Point. Bids will be opened at the local navy yard.

Dump Scow.—The Engineer Office, United States Army, Room 15, Custom House, Norfolk, Va., will receive sealed bids until 12 o'clock noon, March 15, for the purchase of Dump Scow No. 25. Further information on application.

Steel Dump Scows, Pittsburgh, Pa.—The Dravo Contracting Company, Diamond Bank Building, has been awarded a contract for the construction of five steel dump scows by Colonel W. B. Ladue, Corps of Engineers, U. S. Army, Philadelphia, Pa.

Steel Hull, Nashville, Tenn.—United States Engineer Office, War Department, Second District, Custom House, Cincinnati, Ohio, has let a contract for constructing the steel hull for the snag boat Kentucky to the Nashville Bridge Company, Shelby avenue. The hull will cost $28,480.

Stern-Wheel Boat, Pittsburgh, Pa.—The Mississippi River Commission. First and Second Districts, Custom House, Memphis, Tenn., has let a contract for furnishing the stern-wheel steamboat Luther D. Griffith to J. Eichleary, Jr., Twentieth and Wharton streets, at a cost of $41,414.

To Deepen Channel, Galveston, Tex.—United States Engineers, C. L. Hall assistant engineer, invite bids for dredging the second section of the Houston Ship Channel to a depth of 30 feet, width 150 feet. An appropriation of $1,500,000 is recommended to complete depth to turning basin of 30 feet.

Naval Base to Be Expanded, Hawaii.—According to announcement made by Rear Admiral W. B. Shoemaker, who recently arrived at Pearl Harbor to take command there, the United States Naval Base in Hawaii is to be made capable of supplying and taking care of the entire Pacific fleet. Plans for expansion at Pearl Harbor now are under way.

Shipyard Improvement, Mare Island.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., is completing plans for a new plate and structural shape shop at the Mare Island Navy Yard. Bids for the foundation will be taken at once. A new local scrap yard to cost approximately $27,800, with handling equipment, is also included.

Wharf, Etc., Norfolk.—The United States Engineers, War Department, Washington, D. C., has let a contract for constructing a wharf at Norfolk to the Raymond Concrete Pile Company, 921 Munsey Building, Baltimore, Md., at $25,462.50, and the contract for dredging the Elizabeth River to the Norfolk Dredging Company, 217 Water street, at $17,000.

Electric Drive Equipments, Oakland, Cal.—The Coast Guard Service has placed orders for four electric drive equipments for cutters, which will be 3,000 horsepower synchronous motor type. The hull for the first cutter was recently laid at the yard of the Union Construction Company, which holds the contracts for the construction of all four cutters.

Machinery and Other Equipment, South Boston, Mass.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., is re-ising plans for its new building at the South Boston drydocks, to include the installation of a 50-ton steam locomotive crane. The work is estimated at a cost of about $200,000, including machinery, and bids will soon be asked.

Navy Repair Contract.—Announcement is made at Los Angeles, Cal., by Rear Admiral Welles, Commandant of the eleventh naval district, that contracts are about to be closed between the government and a Los Angeles shipbuilding company for repairs to more than 100 destroyers of the Pacific fleet. About $12,000,000, it was stated, will be involved in these contracts.

NEW INCORPORATIONS

Ambrose Lighterage & Transportation Company, Inc., 95 Booraem Avenue, Jersey City, N. J., has been incorporated with a capital of $200,000, to conduct a freighting, lighterage and transportation business.

Hampton Roads Transportation Company, Seaboard Building, Norfolk, Va. Capital, $500,000, with John N. Haden, president: W. B. Baldwin, treasurer; J. C. Dabney, secretary.

Fred E. Jones Dredging Company, Wilmington, Del. Capital, $250,000, to conduct river and harbor improvements.

Matthew Addy Steamship Commerce Corporation, Cleveland, Ohio, has changed its name to the Delaware Steamship & Commerce Corporation.

Miraflores Steamship Corporation, Dover, Del., has been incorporated with a capital of $650,000, to engage in ocean commerce.

New York-New England & Pennsylvania Lighterage Company, Inc., Wilmington, Del. Capital, $100,000, to purchase, charter, hire, operate, own, lease and dispose of vessels, ships and boats.

St. Mary Steamship Corporation Dover, Del. Capital, $650,000, to engage in ocean commerce.

Universal Ship Supply Company, 129 Tazewell Street, has been organized, with J. Garzia, president; J. Larrasquiru, vice-president; P. Astarbi, secretary-treasurer, and capitalized at $50,000.

The Mallory Diesel Electric Corporation, Dover, Del., has been incorporated with a capital of $100,000 to carry on a business of electrical and marine engineers.

The Keeler Transportation Line, Inc., New York, N. Y., has been incorporated with a capital of $500,000 for navigation, by E. A. Keeler, Shore Road, Whitestone, L. I.

Parkersburg Dry Docks Company, Wilmington, Del., was incorporated with a capital of $800,000 to build and do a general towing and river shipping business.

North American Steamship Company, Boston, Mass.; capital, $250,000.

Barr Shipping Corporation, Wilmington, Del., to build, own and operate boats; capital, $900,000.

East Coast Steamship Lines, Inc., Wilmington, Del., to build, own and operate boats; capital, $500,000.

Cox's Shipping Agency, Inc., Dover, Del., a general ship brokerage business; capital, $100,000.

Atlantic, Gulf & Mediterranean Steamship Corporation, Manhattan, navigation; capital, $100,000; incorporated by M. Finkelstein, 341 Stone Avenue, Brooklyn, N. Y.

Betts Lighterage & Wrecking Company, Boston, Mass.; capital, $100,000.

American Maritime Company, Boston, Mass., buying and selling vessels; capital, $50,000.

R. S. Brine Transportation Company, Boston, Mass., transportation and construction; capital, $400,000.

Warren Export Coal Company, incorporated under the laws of Delaware to do a general export business in cargo and bunker coal. W. A. Harriman, New York, has been elected chairman of the board.

The Baltimore Derrick & Salvage Corporation, Dover, Del., was incorporated with a capital of $300,000, to own and operate machinery for salvaging, by Louis E. Broom, Jr., Baltimore, Md.; James F. McLeod, Ridgewood, N. J.; Ralph E. Chapman, Brooklyn, N. Y.

The William Donovan Steamship Company has been formed at Aberdeen, Wash., with a capital of $190,000.

FOREIGN ACTIVITIES

To Improve Harbor.—The government of Brazil has provided an appropriation for harbor improvements at Pernambuco, according to recent reports.

Quay Extension.—R. W. Hawthorne, Leslie & Company, Ltd., have decided to make a quay extension of reinforced concrete to their Hebburn-on-Tyne shipyard. It will be 200 feet long and 40 feet wide.

Building Canals.—According to recent reports, the Ministry of Public Works of the Polish Government is constructing two canals; one of these is a circulatory canal located near Warsaw, and the other is being constructed in West Galicia.

Steamship Service.—The government of Holland introduced a bill into parliament to authorize during a period of five years an annual advance of approximately $291,665 for the support of direct steamship service between Holland and South Africa.

Graving Docks.—The formation of the Netherlands Dock Company at Amsterdam by a number of Dutch shipping companies and Amsterdam banks is announced. A site of 60 acres has been bought. Three graving docks (constructed in reinforced concrete) will be constructed for holding ships of 30,000, 16,000 and 13,000 tons, respectively.

Harbor Work Planned.—Three plans have been presented to the government of Barbados for harbor improvements by an expert who recently visited the colony for that purpose. The expenditure involved reaches from £40,000 ($140,000 at the present rate of exchange) to £200,000 ($700,000). Wharfage for sailing vessels and basins for lighters are the chief requirements. It is reported that the authorities favor the £200,000 plan.

Barges to Be Converted into Tankers.—Five barges, each 240 feet long, which were bought from the government by an English firm, have been brought from the Rhine to Leith and are being converted into oil tankers by Messrs. Henry Robb, Ltd., England. These barges will carry from 1,000 to 1,500 tons of oil and are to be used for supplying oil to oil-burning ships on the Thames. The work will require three or four months for completion.

Zanzibar Harbor Improvements.—The improvement works for Zanzibar harbor, East Africa, will cost, according to original estimates, £250,000 (or approximately $875,000 at the present rate of exchange). The scheme includes the reclamation of about 20 acres of land on Malindi Spit, near town. A concrete wharf, 1,300 feet in length, and a minimum low tide depth of water of 30 feet are included in the plans, and it is intended to install modern equipment of all kinds, including electric cranes.

Contract Awards.—According to the Danzig Journal, Der Osten, the Danziger Werft has been awarded a contract for reconditioning the four ex-German merchant vessels, which under the terms of the Peace Treaty are to be repaired by Germany. These vessels, which during the war were lying in South American harbors, are now being brought to Danzig from there. Three of the vessels have a displacement of 8,000 tons and one is of 18,000 tons. It is expected that work will start on them immediately.

New Steamer.—The steamer Vanellus, recently completed by Swan-Hunter & Wigham, Richardson, Ltd., at their Southwick shipyards, Sunderland, to the order of the Cork Steamship Company, Ltd., of London, and which is intended for the service carried on by that company between Manchester, Liverpool and Dutch and Belgian ports, has been turned over to her owners after a successful trial trip. The steamer is 290 feet long and is designed to carry over 3,100 tons deadweight on a light draft of water.

Lloyd's Figures.—According to returns compiled by Lloyd's Register, which take into account only vessels of 100 tons gross and upwards, there were 921 merchant vessels of

3,708,916 gross tons under construction in the United Kingdom at the close of the three months ended December 31, 1920. In September, 1920, the corresponding figures were 961 vessels of 3,731,098 gross tons. The present figures include sixty-four steamers and motor vessels of 422,553 gross tons, which are intended to carry oil in bulk.

Largest Argentine Merchant Ship.—A vessel, which will be the largest ocean-going merchant steamer owned in the Argentine Republic, is being built by the Ailsa Shipbuilding Company, Ltd., at Troon, for the Sociedad Anonima Importadora y Exportadora de la Patagonia. This vessel will be named Jose Mendenez in honor of the company's first president. She will be 345 feet in length and have a speed of 14 knots. Accommodations will be provided for 200 first-class and over 300 third-class passengers. The vessel is intended for service between Buenos Aires and Patagonia.

Cunard Company Active.—The Cunard Company proposes to build twenty-three new vessels this year, giving a total tonnage of over 300,000. These vessels are to be smaller and swifter than those already owned by that company, and six of the new liners will be of 15,000 tons. The firms who have secured these contracts are Vickers, Ltd., of Barrow-in-Furness; Swan, Hunter & Wigham Richardson, Ltd., of Wallsend-on-Tyne; William Beardmore & Sons, Ltd., of Glasgow; John Brown & Company, Ltd., of Glasgow; Cammell, Laird & Company, Ltd., of Birkenhead; Armstrong, Whitworth & Company, Ltd., of Elswick, and Hawthorne, Leslie & Company, Ltd., of Jarrow-on-Tyne.

New Shipyard.—The new shipyard of the Societe Normande de Construction Navales at Harfleur, France, is nearing completion. This yard is on the north side of the Tancarville Dock and consists of three building berths of 7,000 tons capacity and a launching basin, and a fourth berth is under construction, to be finished later in the year. The company has contracts for eleven ships, eight of which have been ordered by the Bureau National des Charbons, and are to be of 6,500 tons each, while the remaining three will be of 6,800 tons each. The Societe Navale de l'Ouest have placed an order with the Chantiers Navales Francais for an oil tanker of 11,000 tons to be propelled by turbines of 3,000 horsepower, and it is expected that the construction of this vessel will begin immediately.

Colonial Program.—A program which would involve an outlay of 3,000,000,000 francs—2,000,000,000 for railroads, 400,000,000 for ports, and 400,000,000 for improving other waterways and irrigation, 150,000,000 for medical service and 10,000,000 for wireless installation—is suggested for development in the colonies, by M. Sarraut, minister to the colonies, according to advices received by the Bankers Trust Company of New York from its French information service. It is stated that twenty-five new French companies have been organized for development of France's colonial wealth, the capital of these companies ranging from 50,000 francs to 75,000,000 francs. Specific aims of the new corporations are general trade and exploitation of forests, fisheries, oil and cotton industries and improved navigation and transportation.

German Shipbuilding.—Some idea of extent to which German shipbuilding has revived may be gathered from the fact that in Hamburg yards alone there are twenty-eight vessels under construction at the present time, while in addition to these contracts have been placed for fourteen others. The Blohm & Voss yards have four steamers under construction for the Woermann Line, and seven for the Deutsch-Australische Dampfschiff Ges.; the Elbeschiffwerft has three vessels under construction; the Deutsche Werft is building sixteen vessels, two for Dutch account, six for the Hamburg-American Line, and eight for private account. The Reiherstieg Schiffswerft is building two vessels for the firm of A. Kirsten; the Vulkan works has two for the Deutsche Australische Dampfschiffahrts Ges., and three for the German Levant Line. The size of the vessels ranges between 5,000 and 10,000 tons.

TRADE PUBLICATIONS

Tube Cleaner and Soot Blower.—A pamphlet containing a short description of the "Superior" boiler tube cleaner and soot blower manufactured by the Superior Engineering Company, New York, has recently been issued.

Davidson Steam Pumps.—Marine pumps, condensers, ash ejectors, and evaporators are described in specification form in catalogue "B" issued by the M. T. Davidson Company, New York City. A special section is devoted to details of the Davidson improved valve motion for operation without lubrication in pumps under high steam pressure.

Oil Driving Compressors.—Bulletin No. 607 contains a description and various applications of oil-driven compressors manufactured by the Chicago Pneumatic Tool Company, Chicago, Ill. These machines are built in both stationary and portable types. The pamphlet also contains a comparison of the operating costs of oil and steam-driven compressors.

Rope Schedules.—Users of rope will find valuable data in the new all-manila rope schedules recently prepared by the Whitlock Cordage Company, New York. The schedules are mounted in convenient form for reference use. The same information, together with a complete illustrated story of Whitlock products, is contained in a catalogue issued with the schedule cards.

Development of Electricity in the Marine Field.—A booklet recently published by the Cutler Hammer Manufacturing Company, Milwaukee, Wis., tells in brief the story of the evolution of the engine-propelled ship. The requirements peculiar to electric control of ships are discussed and a description of eletcric control of auxiliaries on the motorship "Solitaire" is given.

R. & D. System for Bunker Oil.—A general description of the Row & Davis, Engineers, Inc., New York, system for handling bunker oil from storage in the inner bottom tanks of a vessel is contained in a catalogue issued by this company. The system applies forced circulation to the bunker oil, reliquidizes all the oil in the bunkers and preserves the full fuel value of the oil. An outline of the operating costs of the system is also given.

C-H Brakes.—Electrically operated brakes are described and illustrated in a booklet published by the Cutler Hammer Manufacturing Company, Milwaukee, Wis. The booklet discusses shoe brakes for both direct and alternating current service. Tables of dimensions and ratings for each type of brake are given as well as an explanation of the calculations for determining the correct size of brake for any installation. Illustrations are shown of brakes applied to cranes, hoists, elevators and other machines.

Submarine Signalling.—The construction and operation of standard receiving apparatus of the Submarine Signal Company, Boston, Mass., for receiving signals transmitted through water are described in a bulletin published by this company. The system consists of receiving tanks filled with water or other suitable fluid placed inside a ship. The sounds coming through the water are picked up in the tank by microphones. The signal system utilizing the Fessenden oscillator for both sending and receiving under water signals is also fully described.

The Cooling of Quenching Oil in the Heat Treatment of Steel.—The Griscom-Russell Company, New York City, has published an illustrated booklet describing the necessity for heat treatment of steel, the various quenching mediums and systems commonly used, the advantages of continuous circulation of the medium and the adaptability of the multi-whirl cooler to the cooling of quenching oil. Typical installations showing the layout of the piping are given together with recommendations for the proper size and number of coolers to meet special requirements.

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